EA Engineering, Science, and Technology, Inc.

405 S. Highway 121, Suite C-100
Lewisville, Texas 75056
Telephone: 972-315-3922
Fax: 972-315-5181
www.eaest.com

1 April 2014

Mr. Brian Mueller
Task Order Monitor
U.S. Environmental Protection Agency (EPA) Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

RE: Human Health Risk Assessment for AOC-4
Falcon Refinery Superfund Site
Remedial Investigation/Feasibility Study
EPA Region 6 Remedial Action Contract 2
Contract: EP-W-06-004
Task Order: 0088-RICO-06MC

Dear Mr. Mueller:

EA Engineering, Science, and Technology, Inc. (EA) is enclosing two hard copies and one electronic copy on a compact disk of the Human Health Risk Assessment for AOC-4 for the above-referenced Task Order to EPA.

If you have any questions regarding this submittal, please call me at (972) 315-3922.

Sincerely,

Robert M. Owens

Robert M. Owens
Project Manager

RMO/ab

Enclosure

cc: Michael Pheeny, EPA Contracting Officer (letter only)
Rena McClurg, EPA Project Officer (letter only)
Tim Startz, EA Program Manager (letter only)
File

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TRANSMITTAL OF DOCUMENTS FOR ACCEPTANCE BY EPA		DATE: 1 April 2014	TRANSMITTAL NO.: **0014**
TO: **Mr. Brian Mueller** **U.S. Environmental Protection Agency (EPA) Region 6**		FROM: **Mr. Robert Owens** **EA Engineering, Science, and Technology, Inc.**	
SUBTASK NO.	DELIVERABLE	NO. OF COPIES	
7.3	Human Health Risk Assessment for AOC-4 Falcon Refinery Superfund Site Remedial Investigation/Feasibility Study	EPA - 1 electronic copy on compact disk and 2 hard copies	
ACCEPTANCE ACTION			
DOCUMENTS FOUND ACCEPTABLE (LIST BY SUBTASK NO.)		NAME/TITLE/SIGNATURE OF REVIEWER DATE	

Final Human Health Risk Assessment
Area of Concern 4 (AOC-4)

Remedial Investigation/Feasibility Study

Falcon Refinery Superfund Site
Ingleside, Patricio County, Texas
EPA Identification No. TXD086278058

Remedial Action Contract 2 Full Service
Contract: EP-W-06-004
Task Order: 0088-RICO-06MC

Prepared for

U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Prepared by

EA Engineering, Science, and Technology, Inc.
405 S. Highway 121 Bypass
Suite C-100
Lewisville, Texas 75067
972-315-3922

April 2014
Revision: 00
EA Project No. 14342.88

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	Microgram(s) per liter
µg/m^3	Microgram(s) per cubic meter
µg/mg	Microgram(s) per milligram
ABS	Absorption factor
ADAF	Age-dependent adjustment factor
ADI	Average daily intake
AF	Adherence factor
AOC	Area of Concern
AST	Above ground storage tank
AT	Averaging time
BW	Body weight
CF	Conversion factor
cm^2	Square centimeter(s)
cm^3	Cubic centimeter(s)
COPC	Chemical(s) of potential concern
CR	Ingestion rate
CSM	Conceptual site model
DAD	Dermal absorbed dose
DA_{event}	Dermal absorbed dose per event
DAF	Dosimetric Adjustment Factor
DFSMadj	Mutagenic dermal contact factor
EA	EA Engineering, Science, and Technology, Inc.
EC	Exposure concentration
ED	Exposure duration
EF	Exposure frequency
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERG	Environmental remedial goal
ET	Exposure time
FM	Farm-to-Market
FOD	Frequency of detection
FS	Feasibility Study
GIABS	Gastrointestinal dermal absorption factor

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

HEC	Human Equivalent Concentration
HHRA	Human Health Risk Assessment
HI	Hazard index
HQ	Hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic Model
IFSMadj	Mutagenic Ingestion Rate
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
kg	Kilogram(s)
kg/mg	Kilogram(s) per milligram
L	Liter(s)
L/day	Liter(s) per day
LADI	Lifetime average daily intake
LEC_{10}	10 percent response level concentration
LOAEL	Lowest observed adverse effect level
MCL	Maximum contaminant level
mg/cm^2	Milligram(s) per square centimeter
mg/day	Milligram(s) per day
mg/kg	Milligram(s) per kilogram
mg/kg-BW/day	Milligram(s) per kilogram body weight per day
mg/kg/day	Milligram(s) per kilogram per day
mg/L	Milligram(s) per liter
mg/m^3	Milligram(s) per cubic meter
NCP	National Contingency Plan
NOAEL	No observed adverse effect level
NORCO	National Oil Recovery Corporation
PAH	Polycyclic aromatic hydrocarbon
PEF	Particulate emission factor
RAGS	Risk Assessment Guidance for Superfund
RfC	Reference concentration
RfD	Reference dose

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

RI	Remedial Investigation
RL	Reporting limit
RME	Reasonable maximum exposure
RSL	Regional screening level
SA	Surface area
SF	Slope factor
Site	Falcon Refinery Superfund Site
UCL	Upper confidence limit on the mean
UF	Uncertainty factor

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1. INTRODUCTION

EA Engineering, Science, and Technology, Inc. (EA) has been authorized by the U.S. Environmental Protection Agency (EPA), under Remedial Action Contract Number EP-W-06-004, Task Order 0088-RICO-06MC, to conduct a Remedial Investigation/Feasibility Study (RI/FS) at the Falcon Refinery Superfund Site (Site). EPA's scope of work includes the preparation of a human health risk assessment (HHRA) for the site. EPA has requested that EA prepare a HHRA for the barge dock area (Area of Concern 4 [AOC-4]) and the Intracoastal Waterway (AOC-5) separate from the remaining Site. This document provides the results of the HHRA for AOC-4.

The HHRA is an integral part of the remedial investigation (RI) process included in the Oil and Hazardous Substance National Contingency Plan (NCP) (40 Code of Federal Regulation 300.430) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S. Code 9605). The risk assessment estimates the potential risk and hazard to potential human receptors for exposure to media affected by past activities related to the Site.

1.1 SITE HISTORY

The Site is located 1.7 miles southeast of State Highway 361 on Farm-to-Market (FM) 2725 at the north and south corners of the intersection of FM 2725 and Bishop Road near the City of Ingleside in San Patricio County, Texas (Figure 1). The Site occupies approximately 104 acres and consists of a refinery that operated intermittently and has not produced hydrocarbon products in several years. The refinery is currently inactive, except for a crude oil storage operation being conducted by Superior Crude Gathering, Inc. When in operation the refinery had a capacity of 40,000 barrels per day and the primary products consisted of naphtha, jet fuel, kerosene, diesel, and fuel oil. The refinery also historically transferred and stored vinyl acetate, a substance not excluded under the petroleum exclusion.

The Site is divided into the North Site, South Site and current barge dock facility. There are pipelines that connect the North and South Sites with the current and former barge dock facilities. The North Site consisted of nine above ground storage tanks (ASTs), three truck loading racks, associated piping, and a transfer pump. The South Site consisted of the main operations of the refinery. This area had a control room, heaters, crude towers, coalescers, boilers, fire water tank, exchangers, cooling towers, desalters, exchangers, compressors, a lab, 24 ASTs, separator, clarifiers, and aeration pond (TRC 2013). The barge dock facility is located on Redfish Bay and was used to load and unload crude oil and refined hydrocarbons via pipelines that connect the dock to the North and South Sites.

The Site was proposed to the National Priorities List on September 5, 2002. The Potentially Responsible Party for the Site, National Oil Recovery Corporation (NORCO), entered into an "Administrative Order on Consent" with the EPA on 9 June 2004, to perform and finance the removal action and RI/FS for the site.

In 2012, NORCO sold the former Falcon Refinery to Lazarus Texas Refining I, LLC (Lazarus), which operates the former refinery as a crude oil bulk storage and transfer facility. Lazarus is attempting to obtain a notice of no further action for the barge dock facility to obtain a “bridge loan” until additional funding can be obtained (TRC 2013). Lazarus plans to further develop the Site through remedial actions and upgrades.

The Site has been divided into AOCs based upon former use and location (Figure 2). AOC-1 consists of the Former Operational Units and includes the entire North Site and a drum disposal area and metal waste disposal area of the South Site. AOC-2 includes areas of the refinery that were not used for operations or storage and have no record of releases. AOC-3 encompasses the wetlands immediately adjacent to the Site that are bordered by Bay Avenue, Bishop Road, and a dam on the upstream side; wetlands located between Bishop Road, Sunray Road, Bay Avenue, and residences along Thayer Avenue; and the wetlands between Sunray Road, residences along FM 2725, Gulf Marine Fabricators, Offshore Specialty Fabricators, and the outlet of the wetlands into Redfish Bay. Within AOC-3, there are one active and several abandoned pipelines that lead from the refinery to the barge dock facilities. During June 2006, the abandoned pipelines were cut, the contents of the pipelines were removed, and plates were welded on the pipelines. AOC-4 includes the barge docking facility. AOC-4 is approximately 0.5 acres and is located on Redfish Bay. The fenced facility, which is connected to the refinery by pipelines, is used to load and unload barges. Currently only crude oil passes through the docking facility. Historically, refined products were also loaded and unloaded. AOC-5 encompasses the sediments and surface water within the Intracoastal Waterway adjacent to the barge dock facility. AOC-6 includes the neighborhood along Thayer Road, across from the refinery. AOC-7 includes the neighborhood along Bishop Road, across from the North Site.

1.2 SITE INVESTIGATIONS

Phase I sampling was conducted at the Site in 2007 by the Potentially Responsible Parties. EA conducted Phase II investigation activities in accordance with the Field Sampling Plan (EA 2012a) and Quality Assurance Project Plan (EA 2012b) under this task order in 2013.

1.3 OBJECTIVE

The overall objective of this HHRA is to evaluate potential human health risk under current and potential future conditions at AOC- 4. Specifically, the HHRA presents the following objectives:

- Outline the regulatory basis and guidance for conducting the HHRA
- Outline the methods for determining chemical(s) of potential concern (COPC) for the HHRA
- Present the exposure setting for the site that details local land use, nearby human populations, and potential site activities

- Develop a conceptual site model (CSM) that characterizes relevant contaminant pathways and receptors of concern
- Calculate potential carcinogenic and non-carcinogenic risk to receptors of concern (e.g., any human contact at the site under present or future scenarios)
- Identify areas or media that pose no unacceptable risks to human health and require no further action
- Determine COPC that contribute significantly to overall site risks, which will be used to determine risk-based preliminary remediation goals in the FS
- Provide baseline risks for the no-action alternative in the FS that are used to evaluate risk reduction for each proposed alternative.

1.4 GENERAL HUMAN HEALTH RISK ASSESSMENT APPROACH

The HHRA follows guidance as recommended by EPA. Specific application of guidance throughout the risk assessment process is detailed in Section 2 of this document. The following guidance documents were used for this HHRA:

- Risk Assessment Guidance for Superfund (RAGS), *Volume I: Human Health Evaluation Manual (Part A) (Interim Final)*, EPA/540/1-89/002 (EPA 1989)
- RAGS, Volume I: Human Health Evaluation Manual Supplemental Guidance – *Standard Default Exposure Factors* (Interim Final), Publication 9285.6-03 (EPA 1991a)
- RAGS, Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). EPA/540/R-92/003. December. (EPA 1991b)
- *Guidelines for Data Usability in Risk Assessment (Part A)*. Office of Solid Waste and Emergency Response, Publication OSWER9285.7-09A (EPA 1992)
- *Exposure Factors Handbook*, Volumes I, II, and III (EPA 1997a)
- RAGS, Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments). Office of Emergency and Remedial Response (EPA 2002a)
- *Human Health Toxicity Values in Superfund Risk Assessments*. OSWER9285.7-53. Office of Emergency and Remedial Response (EPA 2003)

- RAGS, *Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment)* Final, EPA/540/R/99/005, OSWER9285.7-02EP, Office of Superfund Remediation and Technology Innovation, July (EPA 2004)

- *Guidelines for Carcinogen Risk Assessment*. Risk Assessment Forum. EPA/630/P-03/001F (EPA 2005a)

- Supplemental Guidance for Assessing Susceptibility From Early-Life Exposure to Carcinogens. Risk Assessment Forum, EPA/630/R-03/003F (EPA 2005b)

- Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part F: Supplemental Guidance for Inhalation Risk Assessment) Final. Office of Superfund Remediation and Technology Innovation, EPA-540-R-070-002 (EPA 2009a)

- *Exposure Factors Handbook*, *2011 Edition*. EPA/600/R-090/052F (EPA 2011)

- Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. Available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm. November (EPA 2013a).

2. HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

The purpose of this HHRA is to evaluate potential human health concerns from exposure to environmental media within AOC-4 that have been affected by past activities. To determine human health concerns, the HHRA evaluates potential sources of contamination and routes of migration based on current and potential future site uses. The HHRA results are based upon potential exposure pathways that can occur or are reasonably likely to occur in the future. Risks determined in the HHRA are considered baseline risks associated with exposure to media affected by the site. The baseline risk assumes no remedial actions or other means of exposure reduction (i.e., the use of personal protective equipment, digging restrictions, etc.). The HHRA evaluates the reasonable maximum exposure (RME) that has the potential to occur at the site. Therefore, HHRA results are considered potential and should be used as a guideline in making risk management decisions.

Following EPA guidance (EPA 1989), the HHRA methodology involves a four-step process: data evaluation and hazard assessment, exposure assessment, toxicity assessment, and risk characterization. The following sections detail each step.

2.1 DATA EVALUATION AND HAZARD ASSESSMENT

In the data evaluation and hazard assessment, available environmental data were compiled and reviewed. The site environmental data are analyzed for data quality and compared to risk-based screening values. The comparison to risk-based screening values allows the HHRA to focus on analytes that may contribute significantly to overall sites risks. Analytes that are below risk-based screening values are below a level that is not considered a concern for human health and do not require further evaluation.

2.1.1 Data Included in the Human Health Risk Assessment

Initial field sampling was conducted in 2007 as a result of an EPA approved RI/FS Field Sampling Plan and Quality Assurance Project Plan for the former refinery, adjacent properties, and background sampling locations (TRC 2013). Analytical data obtained during the sampling was evaluated for ecological exposures, and results indicated that further sampling was necessary to adequately assess certain portions of the Site. Field activities conducted in 2013 as part of the Phase II Field Sampling Plan had objectives relating to this HHRA which included providing data to identify and delineate the extent of COPCs in environmental media, identify potential and complete exposure pathways, and provide data for completion of human health and ecological risk assessments as well as the FS. Appendix A presents the samples collected that were used in this risk assessment. Sample locations are presented in Figure 3.

2.1.2 Data Quality Evaluation

The inclusion or exclusion of data within the HHRA on the basis of analytical qualifiers was performed in accordance with EPA guidance (EPA 1989, 1992). The following procedures were followed if qualifiers were present:

- Analytical results bearing the U- qualifier (indicating that the analyte was not detected at the given reporting limit [RL]) were retained in the data set and considered non-detects at the given RL.

- Analytical results for organic and inorganic analytes bearing the J- qualifier (indicating that the reported value was estimated because the analyte was detected at a concentration below the RL or for other reasons) and L- qualifier (indicating the reported value may be biased low) were retained at the reported concentration.

- Inorganic analytical results bearing the B- qualifier (indicating the analyte was detected between the method detection limit and the RL) were retained at the reported concentration.

If duplicate samples were collected or duplicate analyses were conducted on a single sample, the following guidelines were employed to select the appropriate sample measurement:

- If both samples/analyses show that the analyte was present, the maximum detected concentration of the two results was retained in the dataset.

- If both samples/analyses show no detect values, the maximum of the two non-detect RLs was retained in the dataset.

- If only one sample/analysis indicated that the analyte was present, it was retained in the dataset and the non-detect value was discarded.

Laboratory quality control samples, spikes, and blanks were not included in the HHRA. The frequency of detection (FOD) is based on the number of detected concentrations out of the total number of samples. Since samples were sometimes analyzed for different sets of analytes, the total number of samples used in calculation of the FOD may vary by analyte.

2.1.3 Risk-Based Screening

Risk-based screening was conducted by comparing maximum detected analyte concentrations to risk-based screening concentrations. Any analyte in any medium for which the maximum measured concentration exceeded the risk-based screening concentration was retained as a COPC.

The EPA RSLs (EPA 2013a) were used for risk-based screening purposes in the HHRA. The EPA RSLs combine human health toxicity values with “standard” exposure scenarios to estimate analyte concentrations in environmental media that are considered by the EPA to be protective of human exposures (including sensitive populations), over a lifetime. For instance, a residential scenario assumes a standard exposure of 350 days per year over a 30-year duration. The screening values are based on specific, conservative, fixed levels of risk. For carcinogens, this is

10^{-6}, which is the lower bound for excess lifetime potential carcinogenic risk as defined by the NCP (EPA 1990). For non-carcinogens, the screening values are based on a hazard quotient of 1.0. To account for potential cumulative effects of multiple contaminants affecting the same target organ, one-tenth of the acceptable non-carcinogenic threshold was used for screening. The EPA RSL table identifies some carcinogenic contaminants where the carcinogenic RSL is greater than one-tenth the non-carcinogenic RSL (identified in the EPA RSL tables as "c**"). In these instances, the more conservative one-tenth the non-carcinogenic RSL was used.

Essential nutrients (calcium, magnesium, potassium, and sodium) were eliminated from consideration on the basis of their essential nutrient status. Essential nutrients were not compared to risk-based screening values.

Ground water analytical results were compared to the EPA tap water RSL. Lead is identified as a non-carcinogenic compound in the EPA RSL table. However, the lead RSL was not modified by one-tenth because the lead RSL is based upon blood-lead modeling and not actual toxicity values. The maximum detected lead concentration in ground water and surface water was compared to the EPA maximum contaminant level (MCL) of 15 micrograms per liter (μg/L) for lead in residential and public drinking water (EPA 2009b).

For total chromium, risk-based screening values assumed trivalent chromium. Surrogate compounds were determined for detected analytes that lack specific RSL values. For example, the non-carcinogenic polycyclic aromatic hydrocarbon (PAH) pyrene was used as a surrogate for the non-carcinogenic PAH benzo(g,h,i)perylene. Surrogate compounds were identified on the basis of similarity in chemical structure and toxic properties. The example listed above demonstrates this process; a surrogate non-carcinogenic PAH was chosen to represent other non-carcinogenic PAHs that lack RSL values. Each screening table notes which surrogates were used in the screening process.

2.2 EXPOSURE ASSESSMENT

The second step of the HHRA process is the exposure assessment. In the exposure assessment, the receptors of concern and potential exposure pathways are identified. The COPC in site environmental media are converted into systemic doses, taking into account contaminant concentrations, rates of contact (e.g., ingestion rates), and absorption rates of different COPC. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration).

The exposure assessment includes several steps:

- Evaluating the exposure setting, including a description of the land uses and the potentially exposed human populations
- Developing the CSM identifying the source of contamination, contamination transport and release mechanisms, exposure media, exposure routes, and potentially exposed populations

- Calculating exposure point concentrations (EPCs) for each COPC for each of the complete exposure pathways identified in the CSM

- Identifying the exposure models and parameters with which to calculate the exposure doses

- Calculating exposure doses.

2.2.1 Exposure Setting

AOC-4 is approximately 1.7 acres and is located on Redfish Bay. The fenced facility, which is connected to the refinery by pipelines, is used to load and unload barges. Currently only crude oil passes through the docking facility. Historically, refined products were also loaded and unloaded.

The barge dock facility (AOC-4) contains a dock and several small structures to load and unload crude oil. There have been no known spills or releases within AOC-4.

The site is located in the San Antonio-Nueces Coastal Basin adjacent to Redfish Bay, which connects Corpus Christi Bay to the Gulf of Mexico. Surface water drainage from the site enters the wetlands along the southeastern section of the abandoned refinery. A culvert connects the on-site palustrine/estuarine wetlands to estuarine wetlands. The wetlands then connect to the Intracoastal Waterway and Redfish Bay. Ground water at the site is located approximately two feet below ground surface.

2.2.2 Conceptual Site Model

Based upon the site history and exposure setting, a CSM was formulated for AOC- 4. The CSM presents the potential sources of contamination, routes of migration, and potential receptors. Exposure pathways begin from potential source areas and progress through the environment via various fate and transport processes to potential human receptors. Figure 4 illustrates the CSM. The CSM identifies which exposure pathways are complete and require further evaluation in the HHRA. An exposure pathway describes a mechanism by which a population or individual may be exposed to COPCs at the Site. A completed exposure pathway requires the following four components:

- Source and mechanism of chemical release to the environment
- Environmental transport medium for the released chemical
- Point of potential human contact with the contaminated medium
- Human exposure route at the point of exposure.

All four components must exist for an exposure pathway to be complete and for exposure to occur. Incomplete exposure pathways do not result in actual human exposure and are not included in the exposure assessment and resulting risk characterization.

2.2.2.1 Media of Concern

For AOC-4, media of concern include soil (surface and subsurface soil) and ground water.

2.2.2.2 Receptors of Concern

Within the exposure assessment, EPA (1989, 1991b) guidance requires that plausible exposure under both current and future land use be evaluated in the HHRA. The site is an industrial area. Residents and various businesses are located near the site. As a result, current receptors include workers and trespassers. Future use of the site is expected to remain industrial, and it is not anticipated that the site will be used for residential purposes. However, residents are assessed as potential receptors for the site to provide a baseline evaluation. Residential receptors of concern include a resident adult and child. Ground water sampling within AOC-4 only included results from one monitoring well. Due to the limited ground water sample results, ground water was evaluated qualitatively based upon a comparison to the EPA tap water RSLs.

The following exposure pathways are identified as complete for AOC-4:

- Ingestion of and dermal contact with ground water
- Ingestion of, dermal contact, and inhalation of particulates from surface soil
- Ingestion of, dermal contact, and inhalation of particulates from subsurface soil.

As noted, trespassers may visit the site. Any contact by a trespasser would be infrequent and at a low contact rate. Therefore, the residential exposure to these media adequately accounts for any concerns with trespassers within AOC-4.

2.2.3 Selection of Exposure Point Concentrations

EPCs were derived to quantify concentrations of COPC. For the HHRA, the EPC represents the concentration of COPC in media of concern that a potential receptor is expected to contact over a designated exposure period. Reported concentrations of COPC were used to calculate the 95th percentile upper confidence limit on the mean (95UCL) in each medium of concern (EPA 1989, 1992). For calculation of the 95UCL, each non-detected analyte was assigned a numerical value equal to its RL (EPA 2013b). For U qualified data resulting from higher dilution levels, the result from the undiluted or initial run was included as the result.

The 95UCL was used because assuming long-term contact with the maximum concentration is not reasonable (EPA 1989). The 95UCL was determined through the EPA ProUCL program version 5.0.00 (EPA 2013b). The EPA ProUCL program determines the distribution, sample size, variance, and 95UCL of each COPC data set (EPA 2013b). The EPC is based on the lesser of the maximum detected concentration for a medium or the 95UCL (EPA 2013b). Outputs for the ProUCL program are presented in Appendix B.

2.2.4 Exposure Equations

The next step in the exposure assessment is to estimate COPC intake or exposure for each exposure pathway considered in the HHRA. In the exposure assessment, two different measures of intake are provided, depending on the nature of the effect being evaluated. When evaluating longer-term (i.e., subchronic and chronic) exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time [AT]) (EPA 1989). This measure of intake is referred to as the average daily intake (ADI) and is a less than lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily intake (LADI) (EPA 1989). Detailed equations for determining intake are provided on Tables 7 through 9.

The generic equation to calculate ingestion intake from soil is given below:

$$(L)ADI = \frac{EPC \ x \ CR \ x \ EF \ x \ ED \ x \ CF}{BW \ x \ AT}$$

where

(L)ADI	=	(Lifetime) Average daily intake (mg/kg/day)
EPC	=	Concentration of a COPC in soil (mg/kg)
CR	=	Ingestion Rate (milligrams per day [mg/day])
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days) For non-carcinogens, AT = ED × 365 days/year For carcinogens, AT = 70 years × 365 days/year
CF	=	Conversion Factor (10^{-6} kilograms per milligram [kg/mg]).

The generic equation to calculate dermal intake from soil is given below:

$$(L)ADI = \frac{EPC \ x \ SA \ x \ DA \ x \ EF \ x \ ED \ x \ CF}{BW \ x \ AT}$$

where

(L)ADI	=	(Lifetime) Average daily intake (mg/kg/day)
EPC	=	Concentration of a COPC in soil (mg/kg)
SA	=	Surface Area for Contact (cm^2)
DA	=	Absorbed Dose For soil DA = Absorption Factor (ABS) × Adherence Factor (AF) (mg/cm^2)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)

AT	=	Averaging time (days) For non-carcinogens, AT = ED × 365 days/year For carcinogens, AT = 70 years × 365 days/year
CF	=	Conversion Factor (10^{-6} kg/mg).

For chemicals that are considered mutagenic (described in Section 2.3.2), the generic equation to calculate dermal intake from soil is modified as identified below:

$$(L)ADI = \frac{EPC \ x \ DFSMadj \ \ x \ DA \ x \ EF \ x \ CF}{AT}$$

where

(L)ADI	=	(Lifetime) Average daily intake (mg/kg/day)
EPC	=	Concentration of a COPC in soil (mg/kg)
DFSMadj	=	Mutagenic Dermal Contact Factor For soil (mg-year/kg-day) = (SA × ED × AF × Mutagenic Adjustment Factor/BW)
DA	=	Absorbed Dose For soil DA = Absorption Factor (ABS) (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time (days)
CF	=	Conversion Factor (10^{-6} kg/mg).

The intake of particulates and vapors/gases were calculated using the same equation (EPA 2009a):

$$EC = \frac{C_{air} \ x \ ET \ x \ EF \ x \ ED \ x \ CF_1}{AT \ x \ CF_2}$$

Where,

EC	=	Exposure concentration (milligrams per cubic meter [mg/m^3]or µg/m^3)
C_{air}	=	Concentration of chemical in air (mg/m^3)
ET	=	Exposure time (hours)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF_1	=	Conversion Factor (1,000 µg/mg) (carcinogenic intakes only)
CF_2	=	Conversion Factor (24 hours/day)
AT	=	Averaging time (days) For non-carcinogens, AT = ED x 365 days/yr For carcinogens, AT = 70 years x 365 days/yr

The concentration of chemicals in air resulting from emissions from soil is developed following procedures presented in the EPA Soil Screening guidance (EPA 2002c). The chemical concentration in air is calculated from:

$$C_{air} = C_{soil} \ x \left[\frac{1}{PEF} \right]$$

Where,

C_{air}	=	Concentration of chemical in air (mg/m^3)
C_{soil}	=	Chemical concentration in soil (mg/kg)
PEF	=	Particulate emission factor (m^3/kg)

The PEF relates the concentration of a chemical in soil with the concentration of dust particles in air. For residential exposures, a PEF value of $2.78\text{x}10^9$ is used based a 0.5 acre site and using EPA guidance values for Houston, TX (EPA 2002b). For a construction worker, the PEF is based upon potential construction that may occur at the site. The PEF was calculated based upon excavation, grading, and tilling at the site which results in a PEF from other than vehicle traffic (EPA 2013a).

2.2.5 Selection of Exposure Parameters

The second step in quantifying intake requires the identification of exposure parameters. Exposure parameters include rates of contact (e.g., ingestion rates, skin surface areas, etc.), exposure frequency (EF) and duration, body weight (BW), and averaging time. The contact rate reflects the amount of contaminated media contacted per unit time or event. EF and duration are used to estimate the total time of exposure to COPC in media of concern. The BW represents the average BW over an exposure period (EPA 1989). Specific exposure parameters for each receptor are chosen based on EPA guidance (EPA 1989, 1991a, 1991b, 1997a, 2004, 2011, and 2013a) and other appropriate resources. Exposure parameters specific to AOC-4 are discussed in Section 3.

2.3 TOXICITY ASSESSMENT

Toxicity assessment is the third step of the HHRA process. The toxicity assessment considers the types of potential adverse health effects associated with exposures to COPC, the relationship between the magnitude of exposure and potential adverse effects, and related uncertainties, such as the weight of evidence of a particular COPC carcinogenicity in humans. EPA guidance (EPA 1989) specifies that the assessment be accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether studies demonstrate that exposure to a COPC may cause the incidence of an adverse effect. EPA specifies the dose-response assessment, which involves: (1) EPA's quantitative evaluation of the existing toxicity information, and (2) EPA's characterization of the relationship between the dose of the COPC administered or received, and the incidence of potentially adverse health effects in the exposed population. From this quantitative dose-response relationship, specific toxicity values are derived by EPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels (EPA 1989).

Toxicity values were selected in keeping with appropriate exposure durations and EPA guidance (EPA 2003). Tier 1 values were found using the Integrated Risk Information System (IRIS) (EPA 2014) for established, current values. When toxicity values were not available from IRIS, Tier 2 values were then examined.

Tier 2 values were EPA's Provisional Peer Reviewed Toxicity Values, which are developed by the Office of Research and Development, the National Center for Environmental Assessment, and the Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by the Superfund program.

Tier 3, other toxicity values, were considered when Tier 1 or Tier 2 toxicity values were not available. These toxicity values were taken from additional EPA and non-EPA sources and were chosen based on the most current and best peer-reviewed source available. The California EPA Office of Environmental Health Hazard Assessment Toxicity Criteria Database (California Environmental Protection Agency 2014), California EPA Cancer Potency Values (California Environmental Protection Agency 2009), and the Health Effects Assessment Summary Tables (EPA 1997b) are the Tier 3 sources utilized for this HHRA.

2.3.1 Toxicity Assessment for Non-Carcinogens

The methodology used by EPA for deriving non-cancer reference values for non-carcinogens, and site-specific considerations for modifying or using these concentrations are discussed in detail in Barnes and Dourson (1988) and EPA guidance (EPA 2014a). Non-carcinogens are typically judged to have a threshold daily dose below which deleterious or harmful effects are unlikely to occur. This concentration is called the no-observed-adverse-effect-level (NOAEL), and may be derived from either animal laboratory experiments or human epidemiology investigations (usually workplace studies). In developing a toxicity value or human NOAEL for non-carcinogens (i.e., a reference dose [RfD]), the regulatory approach is to (1) identify the critical toxic effect associated with chemical exposure (i.e., the most sensitive adverse effect); (2) identify the threshold dose in either an animal or human study; and (3) modify this dose to account for interspecies variability (where appropriate), differences in individual sensitivity (within-species variability), and other uncertainty and modifying factors. For the Reference Concentrations (RfCs), experimental exposures are extrapolated to a Human Equivalent Concentration (HEC). The HEC is determined through a two-step process that begins with a point of departure, which is adjusted (multiplied) by a Dosimetric Adjustment Factor (DAF) (EPA 2009a). The point of departure can represent a NOAEL, lowest-observed-adverse-effect-level (LOAEL), benchmark concentration, lower confidence limit, and the lower limit on an effective concentration using a 10 percent response level (LEC_{10}). The DAF is for the specific site of the chemical's effects (e.g., respiratory tract, etc.). The DAF is dependent upon the nature of the contaminant and the target site of the toxic effect.

Uncertainty factors (UFs) are intended to account for specific types of uncertainty inherent in extrapolation from the available data. The UFs are generally 10-fold, default factors used in operationally deriving the RfD and RfC from experimental data. UFs less than 10 can be used. A UF of 3 can be used in place of one-half power ($10^{0.5}$) when appropriate. The UFs are intended to account for (1) variation in susceptibility among the members of the human population (i.e., inter-individual or intraspecies variability), (2) uncertainty in extrapolating animal data to humans (i.e., interspecies uncertainty), (3) uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure (i.e., extrapolating from subchronic to chronic exposure), (4) uncertainty in extrapolating from a LOAEL rather than from an NOAEL, and (5) uncertainty associated with extrapolation when the database is incomplete. The maximum UF for the derivation of the RfCs used in this HHRA is 3,000. The maximum UF for the derivation of the RfDs used in this HHRA is 3,000. To calculate the RfD, the appropriate NOAEL is divided by the product of all the applicable UFs. This is expressed as:

$$RfD = NOAEL / (UF_1 \times UF_2 \times UF_3 \times UF_4)$$

The resulting RfD is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-BW/day). To calculate the RfC, the HEC is divided by UFs and is expressed in units of milligrams per cubic meter (mg/m^3).

2.3.2 Toxicity Assessment for Carcinogenicity

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold. There is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This "non-threshold" concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. EPA uses a two-part evaluation for carcinogenic effects. This evaluation includes the assignment of a weight-of-evidence classification and the quantification of a cancer toxic potency concentration. Quantification is expressed as a slope factor (SF) for oral and dermal exposures and an Inhalation Unit Risk (IUR) for inhalation exposures, which reflects the dose-response data for the carcinogenic endpoint(s) (EPA 1989, 2009a).

The weight-of-evidence classification system assigns a letter or alphanumeric (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen (EPA 1986).[1] The EPA has established six recommended standard hazard descriptors: "*Carcinogenic to Humans*," "*Likely to Be Carcinogenic to Humans*," "*Suggestive Evidence of Carcinogenic Potential*," "*Inadequate Information to Assess Carcinogenic Potential*," and "*Not Likely to Be Carcinogenic to Humans*" (EPA 2005a). The weight-of-evidence classification is based on a thorough scientific examination of the body of available data. Only compounds that

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[1]A = A known human carcinogen; B1 = A probable human carcinogen, based on sufficient animal data and limited human data; B2 = A probable human carcinogen based on sufficient animal data and inadequate or no human data; C = A possible human carcinogen; D = Not classifiable as to human carcinogenicity; and E = Evidence of non-carcinogenicity for humans.

have a weight-of-evidence classification of C or above are considered to have carcinogenic potential in this HHRA.

The SF and the IUR are the upper 95th percentile confidence limit of the probability of response per unit daily intake of a chemical over a lifetime. The SF is expressed in units of proportion (of a population) affected per milligrams per kilograms per day (mg/kg/day). The IUR is expressed in micrograms per cubic meter (µg/m^3). Typically, the SF and the IUR are used to estimate the upper-bound lifetime probability of a person developing cancer from exposure to a given concentration of a carcinogen. SFs and IURs are generally based on experimental animal data, unless suitable epidemiological studies are available. Because of the difficulty in detecting and measuring carcinogenic endpoints at low exposure concentrations, SFs and IURs are typically developed by using a model to fit the available high dose, experimental animal data, and then extrapolating downward to the low-dose range to which humans are typically exposed. EPA recommends the linear multistage model to derive an SF and IUR. The model is conservative and provides an upper bound estimate of excess lifetime cancer risk. These methods and approaches are discussed in greater detail within the EPA *Cancer Guidelines* (EPA 2005a).

Carcinogenic compounds were also assessed for mutagenic modes of action. The mutagenic mode of action is assessed with a linear approach (EPA 2005b). Benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene are the COPC that have been identified with a mutagenic mode of action. COPCs identified as mutagenic have sensitivity pertaining to cancer risks associated with early-life exposures. To account for the early-life exposure and the mutagenic mode of action, the cancer potency estimates are adjusted by an age-dependent adjustment factor (ADAF). The EPA recommends, for mutagenic chemicals, when no chemical-specific data exist, a default approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early life stage exposure (EPA 2005a,b). An ADAF modification for early life stage exposure to mutagenic COPC is required because available studies indicate higher cancer risks resulting from a given exposure occurring early in life when compared with the same amount of exposure during adulthood (EPA 2005b). For this HHRA, the intakes for COPC identified with a mutagenic mode of action are modified by an ADAF for the following (EPA 2005b, 2014):

- For exposures before 2 years of age (i.e., spanning a 2-year time interval from the first day of birth up until a child's second birthday), a 10-fold adjustment.

- For exposures between 2 and <16 years of age (i.e., spanning a 14-year time interval from a child's second birthday up until their sixteenth birthday), a 3-fold adjustment.

- For exposures after turning 16 years of age, no adjustment.

For this HHRA, the resident is within the age range that requires adjustment for a mutagenic mode of action. Two age groups are considered for the residential scenario, an adult and a child. The age group for the child is assumed at 0-6 years. The resident adult is evaluated from an age range of 7-30 years old (EPA 1991b). Although adults are typically assumed at an age range of greater than 16 years of age, the resident adult is evaluated for a long-term exposure typical of residents (EPA 1991b). Residents are typically assumed at a duration of 30 years, so the resident adult spans that 7-30 years beyond childhood (EPA 1991a). Therefore, both the resident child and the resident adult require an adjustment for potential mutagenic modes of action.

2.3.3 Toxicity Assessment Modification for Dermal Contact

Toxicity values specific to dermal exposures are not available and require adjustment of the oral toxicity values (oral RfDs or SFs). This adjustment accounts for the difference between the daily intake dose through dermal contact as opposed to ingestion. Most toxicity values are based on the actual administered dose and must be corrected for the percent of chemical-specific absorption that occurs across the gastrointestinal tract prior to use in dermal contact risk assessment (EPA 1989, 2004). EPA recommends utilizing oral absorption efficiency factors in converting oral toxicity values to dermal toxicity values (EPA 2004). This adjustment accounts for the absorption efficiency in the "critical study," which is utilized in determining the RfD and SF. Where oral absorption in the critical study is essentially complete (i.e., 100 percent), the absorbed dose is equivalent to the administered dose, and no adjustment of oral toxicity values is necessary when evaluating dermal exposures. When gastrointestinal absorption of a chemical in the critical study is poor (e.g., 1 percent), the absorbed dose is much smaller than the administered dose, and toxicity values for dermal exposure are adjusted to account for the difference in the absorbed dose relative to the administered dose. To account for the differences between the administered (oral) and the absorbed (dermal) dose, RfDs and SFs are modified by the gastrointestinal dermal absorption factor (GIABS).

In addition to the GIABS modification of the toxicity values for dermal contact, dermal contact rates are also evaluated based upon a chemical's ability to be absorbed through the skin surface. This absorption rate is dependent upon the medium evaluated. For sediment, the EPA recommends following the same approach used for soil (EPA 2004). For soil, the EPA has identified a dermal absorption factor (ABS) that is chemical-specific. The ABS value reflects the desorption of a chemical from soil and the absorption of the chemical across the skin and into the blood stream. Recommended values are presented that take into account ranges of values that result from different soil types, loading rates, chemical concentrations, and other conditions. Values specific to sediment are not available. The EPA recommends the use of soil ABS values for sediment (EPA 2004).

2.4 RISK CHARACTERIZATION

Risk characterization is the fourth step of the HHRA process. In this step, the toxicity values are combined with the calculated chemical intakes for the receptor populations to quantitatively estimate both carcinogenic and non-carcinogenic risks. Risks were calculated for each receptor of concern.

2.4.1 Hazard Index for Non-Carcinogenic Effects

The potential human health risks associated with exposures to non-carcinogenic COPC are calculated by comparing the ADI or the EC with the chemical-specific RfD or RfC, as per EPA Guidance (EPA 1989, 2009a). A hazard quotient (HQ) is derived for each COPC, as shown in the equation below:

$$HQ = \frac{ADI}{RfD} \quad \text{or} \quad HQ = \frac{EC}{RfC}$$

where

HQ	=	Hazard Quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
ADI	=	Calculated non-carcinogenic average daily intake (mg/kg/day or mg/m^3)
EC	=	Exposure Concentration (mg/m^3)
RfD	=	Reference dose (mg/kg/day)
RfC	=	Reference concentration (mg/m^3).

If the average daily dose exceeds the RfD or RfC, the HQ will exceed a ratio of one (1.0) and there may be concern that potential adverse systemic health effects will be observed in the exposed populations. If the ADI does not exceed the RfD or the RfC, the HQ will not exceed 1.0 and there will be no concern that potential adverse systemic health effects will be observed in the exposed populations. However, if the sum of several HQs exceeds 1.0, and the COPC affect the same target organ, there may be concern that potential adverse systemic health effects will be observed in the exposed populations. In general, the greater the value of the HQ above 1.0, the greater the level of concern. However, the HQ does not represent a statistical probability that an adverse health effect will occur.

For consideration of exposures to more than one chemical causing systemic toxicity via several different pathways, the individual HQs are summed to provide an overall hazard index (HI). If the HI is less than 1.0, then no adverse health effects are likely to be associated with exposures at the site. However, if the total HI is greater than 1.0, separate endpoint-specific HIs may be calculated based on toxic endpoint of concern or target organ (e.g., HQs for neurotoxins are summed separately from HQs for renal toxins). Only if an endpoint-specific HI is greater than 1.0 is there reason for concern about potential health effects for that endpoint.

2.4.2 Carcinogenic Risks

Carcinogenic risk is calculated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the LADI by the risk per unit dose (the SF) or multiplying the EC by the IUR.

This is shown in the following equation:

$$\text{Risk} = \text{LADI} \times \text{SF}$$
$$\text{Risk} = \text{EC} \times \text{IUR}$$

where

Risk	=	Unitless probability of an exposed individual developing cancer
LADI	=	Lifetime cancer average daily intake (mg/kg/day)
EC	=	Exposure Concentration ($\mu g/m^3$)
SF	=	Cancer slope factor $(mg/kg/day)^{-1}$
IUR	=	Inhalation Unit Risk $(\mu g/m^3)^{-1}$.

Because the SF and the IUR are the statistical 95th percent upper-bound confidence limit on the dose-response slope, this method provides a conservative, upper-bound estimate of risk. It should be noted that the interpretation of the significance of the cancer risk estimate is based on the appropriate public policy. EPA in the NCP (40 Code of Federal Regulation Part 300) (EPA 1990) states that:

> *...For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}.*

3. AOC-4, BARGE DOCK FACILITY HHRA

3.1 DATA EVALUATION AND HAZARD ASSESSMENT

Sample locations evaluated for AOC-4 are presented in Appendix A. Risk-based screening, as discussed in Section 2.1.3, was conducted to determine COPCs for AOC-4.

3.1.1 Analytes Exceeding Risk-Based Screening Levels

The occurrence, distribution, and selection of COPCs at the site are represented in Table 1following the RAGS D format (EPA 2002a). The tables present the minimum and maximum detected concentrations, the location of the maximum detected concentrations, as well as, frequency of detection for each chemical detected. Analytes that exceeded the screening criteria and are considered COPCs are presented in bold type.

3.1.1.1 COPCs in Surface Soil

The following COPCs in surface soil (Table 1) were identified based on the residential soil RSL risk-based screen: aluminum, arsenic, cobalt, iron, lead, manganese, mercury, selenium, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

3.1.1.2 COPCs in Subsurface Soil

The following COPCs in subsurface soil (Table 2) were identified based on the residential soil RSL risk-based screen: arsenic, mercury, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

3.1.1.3 COPCs in Ground Water

The following COPCs in ground water (Table 3) were identified based on the tap water RSL risk-based screen: total and dissolved arsenic and total and dissolved manganese.

3.2 EXPOSURE ASSESSMENT

Media evaluated for AOC-4 includes surface soil, subsurface soil, and ground water. The site is currently undeveloped with no buildings. Typically, the construction of buildings and associated utilities would require the mixing of surface soil and subsurface soil. The analytical results and the risk-based screening results were reviewed before surface soil and subsurface soil results were combined to represent a total soil media. Surface soil analytical results were typically higher and resulted in more COPCs identified than subsurface soil. Therefore, surface soil and subsurface soil were evaluated separately. Only one ground water sample was collected from MW-17. Due to the limited number of ground water sample results, ground water is only evaluated qualitatively in relation to the EPA tap water RSL. EPCs for surface soil and subsurface soil were calculated in accordance with Section 2.2.3. ProUCL outputs for the determination of EPCs are provided for each COPC in Appendix B. The results of the EPC selection are summarized in Tables 4 through 6, including the rationale for EPC selection.

Receptors evaluated for AOC-4 include resident adult and child and construction worker. Trespassers are potential receptors for AOC-4; however, a trespassers exposure is expected to be infrequent and result in low contact. The residential receptor provides a protective evaluation for the trespasser. Additionally, the construction worker provides a protective evaluation of potential risk concerns for contact with AOC-4 for all potential workers who may visit. A conceptual site model presenting pathways that were considered is provided in Figure 3. Exposure parameters and equations for each receptor and pathway are presented in medium-specific Tables 7 through 9.

As part of the exposure assessment, the determination of intake requires the identification of exposure parameters. Exposure parameters include rates of contact (e.g., ingestion rates, skin surface areas, etc.), EF and duration, body weight (BW), and averaging time. The contact rate reflects the amount of contaminated media contacted per unit time or event. EF and duration are used to estimate the total time of exposure to COPCs in media of concern. The BW represents the average BW over an exposure period (EPA 1989). Specific exposure parameters for each receptor are chosen based on EPA guidance (EPA 1989, 1991a, 1991b, 1997a, 2004, 2011, and 2013a).

3.2.1 Soil Exposure Assessment

Exposure parameters for resident adult and child exposure to soil are presented on Tables 7 and 8, and exposure parameters for the construction worker are presented on Table 9. The ingestion rate for residential exposure to soil is presented in multiple EPA guidance documents and is assumed at 100 mg/kg for the adult and 200 mg/kg for the child (EPA 1991a, 1991b, 2011, and 2013a). The ingestion rate for the construction worker was taken from guidance for the calculation of the EPA RSLs and Supplemental Guidance for Developing Soil Screening Levels (EPA 2002b, 2013a). A construction worker soil ingestion rate of 330 mg/kg is assumed. Dermal exposure to soil is assumed for exposed body surface areas only. The surface area (SA) available for contact is presented in the EPA RAGS E guidance and generally assumes hands, forearms, head, and feet for the resident. The recommended SA for the adult is 5,700 cm^2 and the child is 2,800 cm^2, based on the mean SA (EPA 2004). The construction worker/site worker is only assumed to contact soil with hands, forearms, and head with a mean SA of 3,300 cm^2 (EPA 2004). The inhalation of soil particulates assumes a 24 hour exposure period for the resident and an 8 hour work day for the construction worker. The resident adult and construction worker were assumed to weigh 70 kg, and the resident child was assumed to weigh 15 kg. The resident adult is expected to be exposed to soil for a 24-year duration at a frequency of 350 days per year. The resident child was expected to be exposed to soil for 6 years at a frequency of 350 days per year. The construction worker was assumed to contact soil for 250 days per year over a one year construction period.

3.3 TOXICITY ASSESSMENT

EPA-derived toxicity values for evaluating potential chronic non-carcinogenic effects for COPCs are summarized in Tables 10 and 11. Toxicity information presented in these tables includes the following EPA-provided/derived information: chronic RfD or RfC values for exposures via the oral and inhalation pathway; reported target organs, uncertainty, and modifying factors specific to the EPA-derived RfD or RfC; and the scientific source of the information. Table 12 presents relative chemical-specific parameters utilized in calculating dermal exposure for COPCs.

EPA-derived toxicity values for evaluating potential carcinogenic effects for COPCs are summarized in Tables 13 and 14. Toxicity information presented in these tables includes the following EPA-provided/derived information: a chemical-specific SF or IUR (cancer potency factor) for exposures via the oral and inhalation pathway; EPA's weight-of-evidence cancer classification; and the source of the information.

Lead is considered a COPC in surface soil only (Table1). The EPA has not established cancer SFs or non-cancer RfDs for lead. In the absence of any EPA-published toxicity values for lead, it is currently not possible to perform a quantitative risk estimate for lead exposures using standard EPA methodology. Much of the toxicological data collected on the effects of lead in humans relates to exposure and effect in terms of the amount of lead in blood associated with an observed effect, expressed as micrograms of lead per deciliter of blood (µg lead/dL blood). The EPA and Centers for Disease Control and Prevention have identified childhood blood-lead levels of 10 µg/dL as the level of concern above which significant health risks may occur. According to the EPA, lead is classified as a B2, probable human carcinogen. However, lead is not regulated as a carcinogen because it appears to be more potent as a toxicant to the hemopoietic system by inhibiting heme synthesis. Because lead is not evaluated via traditional risk assessment methodologies, lead in site media were evaluated through the use of blood-lead models. For the residential scenario, lead concerns for potential future child residents were evaluated using EPA's Integrated Exposure Uptake Biokinetic Model (IEUBK) Lead Model (EPA 2010). The IEUBK model takes into account an average lead concentration in soil (EPA 1994, 2002c).

3.4 RISK CHARACTERIZATION

The methodologies used to quantify carcinogenic risks and chronic hazards for non-carcinogens are described further in Section 2.2. Calculations are presented by receptor in Tables 15 through 20. Tables 21 and 22 present the estimation of COPC air concentrations of particulate from soil for the resident and construction worker, respectively. Table 23 presents a summary of the IEUBK blood-model outputs. Outputs from the IEUBK model are provided in Appendix D.

Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for all receptors are presented in Tables 24 through 27. If cumulative non-carcinogenic hazards are greater than 1.0, a breakdown by target organ is provided.

3.4.1 Surface Soil

3.4.1.1 Resident Adult and Child

Calculations for the resident adult and child are presented in Tables 15 and 16. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Table 24. The total non-carcinogenic HI for the resident adult is 0.2, which is below the acceptable threshold of 1.0 (Table 24). The total non-carcinogenic HI for the resident child is 2, which is above the acceptable threshold of 1.0 (Table 24). No COPC has a chemical-specific HQ greater than 1. A breakdown by target organ is provided for the resident child on Table 24. No target organ has an HI greater than 1.

Carcinogenic risks for the resident adult and child are combined to account for an excess, lifetime cumulative carcinogenic risk. The cumulative carcinogenic risk for the resident adult and child is 5×10^{-5} (Table 24), which is within the EPA's target risk range of 10^{-4} to 10^{-6}. Benzo(a)pyrene is the only COPC with carcinogenic risks greater than 10^{-5}. All other COPCs, except cobalt, have carcinogenic risks greater than 10^{-6}.

3.4.1.2 Construction Worker

Calculations for the construction worker are presented in Table 17. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Table 25. The total non-carcinogenic HI for the construction worker is 0.6, which is below the acceptable threshold of 1.0 (Table 25).

The carcinogenic risk for the construction worker is 6×10^{-7} (Table 25), which is below the EPA's target risk range of 10^{-4} to 10^{-6}.

3.4.2 Subsurface Soil

3.4.2.1 Resident Adult and Child

Calculations for the resident adult and child are presented in Tables 18 and 19. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Table 26. The total non-carcinogenic HI for the resident adult is 0.04, which is below the acceptable threshold of 1.0 (Table 26). The total non-carcinogenic HI for the resident child is 0.3, which is below the acceptable threshold of 1.0 (Table 26).

Carcinogenic risks for the resident adult and child are combined to account for an excess, lifetime cumulative carcinogenic risk. The cumulative carcinogenic risk for the resident adult and child is 2×10^{-5} (Table 26), which is within the EPA's target risk range of 10^{-4} to 10^{-6}. Benzo(a)pyrene is the only COPC with carcinogenic risks greater than 10^{-5}. Arsenic, benz(a)anthracene, and benzo(b)fluoranthene have carcinogenic risks greater than 10^{-6}.

3.4.2.2 Construction Worker

Calculations for the construction worker are presented in Table 20. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Table 27. The total non-carcinogenic HI for the construction worker is 0.08, which is below the acceptable threshold of 1.0 (Table 27).

The carcinogenic risk for the construction worker is 2×10^{-7} (Table 27), which is below the EPA's target risk range of 10^{-4} to 10^{-6}.

3.4.3 Ground Water

Both arsenic and manganese are considered COPCs for both the total and dissolved fractions. The concentration of both analytes is similar for both fractions, which reveals that arsenic and manganese are present primarily in the dissolved phase in ground water. The maximum detected concentration of dissolved arsenic (60.8 µg/L) exceeds both the arsenic tap water RSL (0.045 µg/L) and the MCL (10 µg/L). The maximum detected arsenic concentration is approximately three orders of magnitude higher than the tap water RSL, which would result in carcinogenic risk levels above the EPA acceptable risk range. The maximum detected concentration of dissolved manganese (133 µg/L) exceeds modified (i.e., by 1/10th) the tap water RSL (32.0 µg/L). However, the maximum concentration does not exceed the full tap water RSL of 320 µg/L. This reveals that the concentration of manganese would be below the acceptable non-carcinogenic hazard of 1.

3.4.4 Lead Evaluation

Lead is a COPC in surface soil only. The maximum detected concentration (484 mg/kg) is greater than the residential soil RSL (400 mg/kg). Therefore, the EPA IEUBK model was run to evaluate the resident child. Only location of the maximum detected concentration, FR-133A, exceeds the RSL. The arithmetic mean for lead in surface soil is 83.6 mg/kg. Results of the lead modeling for resident children are presented in Table 23. Outputs of the IEUBK model are presented in Appendix D including probability density graphs. The model indicates a mean blood-lead level of 1.65 µg/L with only 0.006 percent exceeding the acceptable level, which reveals lead in soil would not result in elevated blood-lead levels.

3.5 AOC-4 CONCLUSIONS

The AOC-4 HHRA evaluated potential cumulative risks for the resident adult and child and construction worker exposure to surface soil and subsurface soil. Evaluation of non-carcinogenic hazards did not exceed 1.0 for any of the receptors. Carcinogenic risks for all receptors evaluated are within or below the U.S. EPA's "acceptable risk range." Blood-lead modeling documented that lead in soil would not result in elevated blood-lead levels in children living in proximity to AOC-4.

Ground water was elevated qualitatively because only one sample result is available. The maximum detected concentration of dissolved arsenic (60.8 µg/L) exceeds both the arsenic tap water RSL (0.045 µg/L) and the MCL (10 µg/L). The maximum detected arsenic concentration is approximately three orders of magnitude higher than the tap water RSL, which would result in carcinogenic risk levels above the EPA acceptable risk range.

4. RISK ASSESSMENT UNCERTAINTY

There are numerous uncertainties involved in the HHRA process. These are discussed briefly in the following sections.

4.1 SAMPLING AND ANALYSIS UNCERTAINTIES

The sampling plan can have a significant impact on the results obtained in calculating human health risks at a site. There are no identified uncertainties associated with the data set used in the HHRA.

4.2 UNCERTAINTIES ANALYSIS OF EXPOSURE ASSESSMENT

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment. Exposure is evaluated only within the AOC boundaries. The delineation of the AOC boundaries allows for a determination of potential human health concerns for the AOC itself but does not necessarily represent actual exposure that would occur. The size of AOC-4 is representative of a residential yard, which limits the uncertainty associated with this area.

4.2.1 Dermal Exposures

Dermal contact rates for COPC in soil are evaluated based upon a chemical's ability to be absorbed through the skin surface. The EPA has identified a dermal ABS that reflects the desorption of a chemical from soil and the absorption of the chemical across the skin and into the blood stream. ABS values are not available for most inorganics in EPA RAGS E guidance (EPA 2004). Dermal contact with skin is expected to be a significant exposure, especially for children. However, inorganics are often not well-absorbed through the skin. It is difficult to estimate the effects of generic ABS values on risk results. The absorption of inorganics is primarily a concern if skin is occluded (EPA 1995). However, non-occluded skin is not expected to have absorption. Therefore, risks determined for the dermal contact exposure pathway are most likely overestimated.

4.3 UNCERTAINTIES OF TOXICITY ASSESSMENT

There are numerous uncertainties associated with the toxicity assessment. These are generally due to the unavailability of data to thoroughly calculate the toxicity of COPC. These uncertainties are described in more detail in the following sections.

4.3.1 Uncertainties Associated with Non-Carcinogenic Effects

4.3.1.1 Interspecies Extrapolation

The majority of toxicological information comes from experiments with laboratory animals. Experimental animal data have been relied on by regulatory agencies to assess the hazards of chemical exposures to humans. Interspecies differences in chemical absorption, metabolism, excretion, and toxic response are not well understood; therefore, conservative assumptions are applied to animal data when extrapolating to humans. These probably result in an overestimation of toxicity.

4.3.1.2 Intraspecies Extrapolation

Differences in individual human susceptibilities to the effects of chemical exposures may be caused by such variables as genetic factors (e.g., glucose-6-phosphate dehydrogenase deficiency), lifestyle (e.g., cigarette smoking and alcohol consumption), age, hormonal status (e.g., pregnancy), and disease. To take into account the diversity of human populations and their differing susceptibilities to chemically induced injury or disease, a safety factor is used. EPA uses a factor between 1 and 10. This uncertainty may lead to overestimates of human health effects at given doses.

4.3.2 Exposure Routes

When experimental data available on one route of administration are different from the actual route of exposure that is of interest, route-to-route extrapolation must be performed before the risk can be assessed. Several criteria must be satisfied before route-to-route extrapolation can be undertaken. The most critical assumption is that a chemical injures the same organ(s) regardless of route, even though the injury can vary in degree. Another assumption is that the behavior of a substance in the body is similar by all routes of contact. This may not be the case when, for example, materials absorbed via the gastrointestinal tract pass through the liver prior to reaching the systemic circulation, whereas by inhalation the same chemical will reach other organs before the liver. However, when data are limited, these extrapolations are made and may result in overestimates of human toxicity.

4.3.3 Uncertainties Associated with Carcinogenic Effects

4.3.3.1 Interspecies Extrapolation

The majority of toxicological information for carcinogenic assessments comes from experiments with laboratory animals. There is uncertainty about whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a very small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animal species, but not in others, raises the possibility that not all animal carcinogens are human carcinogens. Regulatory agencies assume that humans are as sensitive to carcinogens as the most sensitive animal species.

This policy decision, designed to prevent underestimation of risk, introduces the potential to overestimate carcinogenic risk.

4.3.3.2 High-Dose to Low-Dose Extrapolation

Typical cancer bioassays provide limited low-dose data on responses in experimental animals for chemicals being assessed for carcinogenic or chronic effects. The usual dose regime involves three dose groups per assay. The first dose group is given the highest dose that can be tolerated, the second is exposed to one-half that dose, and the third group is unexposed (control group) (National Research Council 1983). Because this dosing method does not reflect how animals would react to much lower doses of a chemical, a dose-response assessment normally requires extrapolation from high to low doses using mathematical modeling that incorporates to varying degrees information about physiologic processes in the body (National Research Council 1983).

A central problem with the low-dose extrapolation models is that they often fit the data from animal bioassays equally well, and it is not possible to determine their validity based on goodness of fit. Several models may fit experimental data equally well, but all may not be equally plausible biologically. The dose-response curves derived from different models diverge substantially in the dose range of interest (National Research Council 1983). Therefore, low-dose extrapolation is more than a curve-fitting process, and considerations of biological plausibility of the models must be taken into account before choosing the best model for a particular set of data.

4.3.4 Modification for Mutagenic Compounds

Carcinogenic slope factors for compounds identified with a mutagenic mode of action for early-life exposure are modified by a default adjustment factor. The default adjustment factors are used because chemical-specific data are not available to directly assess cancer susceptibility from early-life exposure to a carcinogen acting through a mutagenic mode of action. The default adjustment factors are derived from a weighted geometric mean tumor incidence ratio. Therefore, the use of the default adjustment factors may both over-estimate and under-estimate the potential potency for early-life exposure for chemicals with a mutagenic mode of action for carcinogenesis (EPA 2005b). However, the analysis of potential exposure over a lifetime reduces the effects and uncertainty of the mutagenic adjustments on estimated lifetime cancer risk. Carcinogenic risks for receptors identified within the early-life exposure age range are determined based upon a lifetime exposure. The resulting uncertainty in the use of the mutagenic default adjustment factors is reduced but some uncertainty still remains in the use of default factors over a specified age range rather than chemical-specific data.

5. CONCLUSIONS

The HHRA estimated the risk and hazard to potential human receptors for exposure to media within AOC-4 of the former Falcon Refinery Superfund Site. The Site is an inactive refinery located 1.7 miles southeast of State Highway 361 on FM 2725 at the north and south corners of FM 2725 and Bishop Road. The site occupies approximately 104 acres in Ingleside, San Patricio County, Texas. The site is divided into the North Site, South Site, and current barge dock facility. There are pipelines that connect the North and South Sites with the current and former barge dock facilities. The North Site consisted of nine ASTs, three truck loading racks, associated piping and a transfer pump. The South Site consisted of the main operations of the refinery. This area had a control room, heaters, crude towers, coalescers, boilers, fire water tank, exchangers, cooling towers, desalters, exchangers, compressors, a lab, 24 ASTs, separator, clarifiers, and aeration pond (TRC 2013). The barge dock facility is located on Redfish Bay and was used to load and unload crude oil and refined hydrocarbons via pipelines that connect the dock to the North and South Sites.

The site has been divided into AOCs based upon former use and location. AOC-1 consists of the Former Operational Units. AOC-1 includes the entire North Site and a drum disposal area and metal waste disposal area of the South Site. AOC-2 includes areas of the refinery that were not used for operations or storage and have no record of releases. AOC-3 encompasses the wetlands immediately adjacent to the site that are bordered by Bay Avenue, Bishop Road, and a dam on the upstream side; wetlands located between Bishop Road, Sunray Road, Bay Avenue and residences along Thayer Avenue; and the wetlands between Sunray Road, residences along FM 2725, Gulf Marine Fabricators, Offshore Specialty Fabricators and the outlet of the wetlands into Redfish Bay. Within AOC-3, there are one active and several abandoned pipelines that lead from the refinery to the barge dock facilities. During June 2006 the abandoned pipelines were cut, the contents of the pipelines were removed and plates were welded on the pipelines. AOC-4 includes the barge docking facility. AOC-4 is located on Redfish Bay. The fenced facility, which is connected to the refinery by pipelines, is used to load and unload barges. Currently only crude oil passed through the docking facility. Historically, refined products were also loaded and unloaded. AOC-5 encompasses the sediments and surface water adjacent to the barge dock facility (AOC-4). AOC-6 includes the neighborhood along Thayer Road, across from the refinery. AOC-7 includes the neighborhood along Bishop Road, across from the North Site.

AOC-4 is approximately 0.5 acres and is located on Redfish Bay. The fenced facility, which is connected to the refinery by pipelines, is used to load and unload barges. Currently only crude oil passed through the docking facility. Historically, refined products were also loaded and unloaded.

AOC-4 is fenced and contains a dock and several small structures to load and unload crude oil. There have been no known spills or releases within AOC-4.

The site is located in the San Antonio-Nueces Coastal Basin adjacent to Redfish Bay, which connects Corpus Christi Bay to the Gulf of Mexico. Surface water drainage from the site enters the wetlands along the southeastern section of the abandoned refinery. A culvert connects the on-site palustrine/estuarine wetlands to estuarine wetlands. The wetlands then connect to the Intracoastal Waterway and Redfish Bay. Ground Water at the site is located approximately two feet below the ground's surface.

Receptors identified for AOC-4 include the resident adult, resident child, and construction worker. Site workers (i.e., landscapers/maintenance workers) and trespassers may also contact AOC-4. However, these receptors are expected to have relatively low contact with the area. The residential and construction worker exposure scenario represents conservative exposure scenarios that would account for all other expected receptor contact with the site. Media of concern for AOC-4 include surface soil, subsurface soil, and ground water. Only one ground water sample was collected within AOC-4. As a result, ground water was evaluated qualitatively. Specific exposure pathways evaluated in the AOC-4 HHRA are presented in Figure 4.

The following table presents a summary of the HHRA results.

Human Health Risk Assessment Summary of Results

Receptor	Media	Carcinogenic Risks[1]	Non-Carcinogenic Hazards	COPC Contributing Significantly to Results
AOC-4				
Surface Soil				
Child Resident[1]	Surface Soil	5×10^{-5}	2	Not Applicable
Adult Resident[1]	Surface Soil	5×10^{-5}	0.2	Not Applicable
Construction Worker	Surface soil	6×10^{-7}	0.6	Not Applicable
Subsurface Soil				
Child Resident[1]	Subsurface Soil	2×10^{-5}	0.3	Not Applicable
Adult Resident[1]	Subsurface Soil	2×10^{-5}	0.04	Not Applicable
Construction Worker	Subsurface soil	2×10^{-7}	0.08	Not Applicable
1 Cancer risk for the resident adult and child is presented as a total lifetime cumulative cancer risk.				

The results indicate that there are no human health concerns for exposure to AOC-4. The HHRA only evaluated potential resident adult and child exposure and construction worker exposure to soil in AOC-4. Other potential receptors may contact these media. These receptors include landscapers/maintenance workers and trespassers. These workers and trespassers would be expected to visit the site infrequently at contact rates lower than the resident or construction worker. The evaluation of a residential and construction worker exposure represents a receptor that is expected to have higher contact with these media. Therefore, the conclusion that there are no human health concerns for residential or construction worker exposure also applies to any other receptors who may visit AOC-4.

Ground water was evaluated qualitatively because only one sample result is available for AOC-4. The maximum detected concentration of dissolved arsenic (60.8 µg/L) exceeds both the arsenic tap water RSL (0.045 µg/L) and the MCL (10 µg/L). The maximum detected arsenic concentration is approximately three orders of magnitude higher than the tap water RSL, which would result in carcinogenic risk levels above the EPA acceptable risk range. However, one sample result is not representative of typical exposure to ground water as a tap water source.

In conclusion, the HHRA did not reveal potential concerns for human health exposure at AOC-4.

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FIGURES

Image Source:
ESRI ArcGIS Online USA Topo Maps layer, 1:100,000 scale, Copyright:© 2011 National Geographic Society, i-cubed

Falcon Refinery Superfund Site
Ingleside, San Patricio County, Texas

Figure 1
Location Map
Human Health Risk Assessment for AOC-4

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N

0 250 500
Feet

Legend:

Area of Concern Boundary

Active NORCO Pipeline

Above ground

Underground

Abandonded NORCO Pipeline

Above ground

Underground

Outside Operations

Gulf South Pipeline

Boss Pipeline

Gathering Line 2'

Plains Marketing Pipeline

Source: AOC and pipeline locations from TRC, dated, March 10, 2011

Image Source: 2009 Texas Orthoimagery Program, Texas Strategic Mapping Program, TNRIS, 2009

Falcon Refinery Superfund Site
Ingleside, San Patricio County,Texas

Figure 2
Site Map
Human Health Risk Assessment for AOC-4

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Note:
Sample locations G-57S through G-61S comprise composite sample FR-133A

Source: AOC and pipeline locations from TRC, dated, March 10, 2011

Image Source: 2009 Texas Orthoimagery Program, Texas Strategic Mapping Program, TNRIS, 2009

Falcon Refinery Superfund Site
Ingleside, San Patricio County, Texas

Figure 3
AOC-4 Sample Locations
Human Health Risk Assessment for AOC-4

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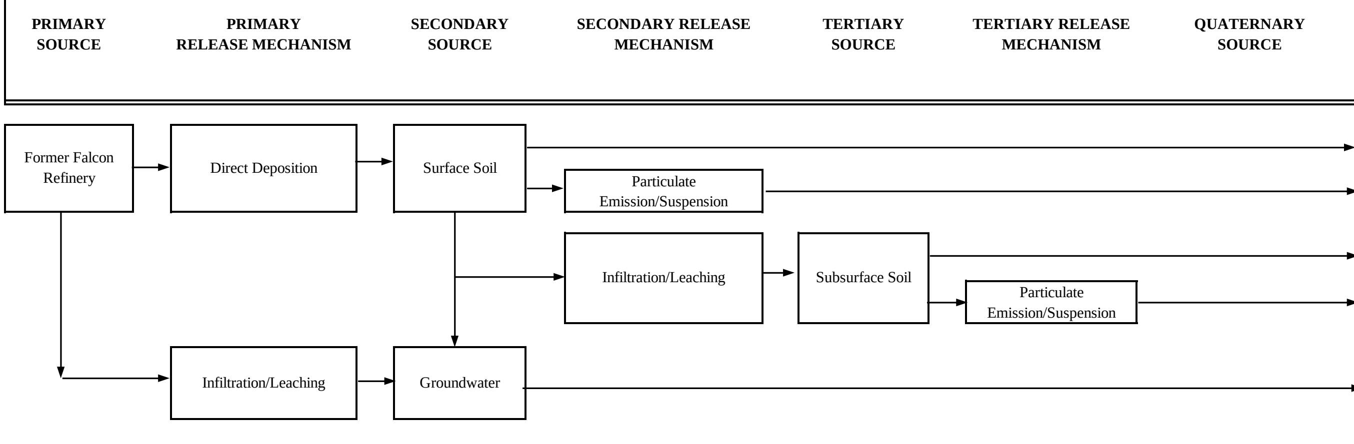
FIGURE 4
HUMAN HEALTH CONCEPTUAL SITE MODEL
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS



EXPOSURE ROUTE	POTENTIAL RECEPTORS			
	Hypothetical Residents (Adult and Child)	Construction Workers	Commercial Worker	Landscaper/Maintenance Worker
Ingestion	C	C	C	C
Dermal Contact	C	C	C	C
Inhalation of Particulate	C	C	C	C
Ingestion	C	C	I	I
Dermal Contact	C	C	I	I
Inhalation of Particulates	C	C	I	I
Ingestion	C	C	I	I
Dermal Contact	C	C	I	I
Inhalation of VOCs	I	I	I	I

LEGEND

I	Incomplete or negligible exposure pathway
C	Potentially complete exposure pathway

TABLES

TABLE 1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
AOC-4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL - RESIDENTIAL
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future-Residential
Medium: Surface soil
Exposure Medium: Surface soil
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value		Potential [5] ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [6] Contaminant Deletion or Selection
							Inorganics										
7429-90-5	**Aluminum**	**2.00E+03**		**1.70E+04**		**mg/kg**	**SO4-01-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**1.70E+04**	**NA**	**7.70E+03**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-36-0	Antimony	4.75E-01	B	4.75E-01	B	mg/kg	FR-133A	1/7	0.00E+00 - 1.30E+00	4.75E-01	NA	3.10E+00	N	NA	NA	No	BSL
7440-38-2	**Arsenic**	**9.40E-01**		**5.70E+00**		**mg/kg**	**SO4-01-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**5.70E+00**	**NA**	**6.10E-01**	**C**	**NA**	**NA**	**Yes**	**ASL**
7440-39-3	Barium	8.14E+01		8.09E+02		mg/kg	SO4-01-0.0-0.5	7/7	0.00E+00 - 0.00E+00	8.09E+02	NA	1.50E+03	N	NA	NA	No	BSL
7440-41-7	Beryllium	1.80E-01	B	1.80E-01	B	mg/kg	FR-133A	1/7	0.00E+00 - 6.60E-01	1.80E-01	NA	1.60E+01	N	NA	NA	No	BSL
7440-43-9	Cadmium	2.70E-01	B	9.00E-01		mg/kg	SO4-01-0.0-0.5	2/7	0.00E+00 - 5.80E-01	9.00E-01	NA	7.00E+00	N	NA	NA	No	BSL
7440-70-2	Calcium	2.17E+04		2.64E+05		mg/kg	SO4-03-0.0-0.5	6/6	0.00E+00 - 0.00E+00	2.64E+05	NA	NA		NA	NA	No	NUT
7440-47-3	Chromium	2.00E+00		1.76E+01	J	mg/kg	SO4-04-0.0-0.5	7/7	0.00E+00 - 0.00E+00	1.76E+01	NA	1.60E+04	N	NA	NA	No	BSL
7440-48-4	**Cobalt**	**7.20E-01**		**3.80E+00**		**mg/kg**	**SO4-01-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**3.80E+00**	**NA**	**2.30E+00**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-50-8	Copper	2.80E+00		3.98E+01		mg/kg	SO4-04-0.0-0.5	7/7	0.00E+00 - 0.00E+00	3.98E+01	NA	3.10E+02	N	NA	NA	No	BSL
7439-89-6	**Iron**	**2.25E+03**	**J**	**1.30E+04**		**mg/kg**	**SO4-01-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**1.30E+04**	**NA**	**5.50E+03**	**N**	**NA**	**NA**	**Yes**	**ASL**
7439-92-1	**Lead**	**8.60E+00**		**4.84E+02**		**mg/kg**	**FR-133A**	**7/7**	**0.00E+00 - 0.00E+00**	**4.84E+02**	**NA**	**4.00E+02**		**NA**	**NA**	**Yes**	**ASL**
7439-95-4	Magnesium	1.16E+03		6.01E+03		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	6.01E+03	NA	NA		NA	NA	No	NUT
7439-96-5	**Manganese**	**6.50E+01**		**2.59E+02**	**J**	**mg/kg**	**SO4-01-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**2.59E+02**	**NA**	**1.80E+02**	**N**	**NA**	**NA**	**Yes**	**ASL**
7439-97-6	**Mercury**	**1.30E-01**		**1.50E+00**		**mg/kg**	**SO4-01-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**1.50E+00**	**NA**	**1.00E+00**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-02-0	Nickel	1.48E+00	B	1.85E+01		mg/kg	SO4-01-0.0-0.5	7/7	0.00E+00 - 0.00E+00	1.85E+01	NA	1.50E+02	N	NA	NA	No	BSL
7440-09-7	Potassium	6.05E+02		4.00E+03		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	4.00E+03	NA	NA		NA	NA	No	NUT
7782-49-2	**Selenium**	**4.28E+02**	**B**	**4.28E+02**	**B**	**mg/kg**	**FR-133A**	**1/7**	**0.00E+00 - 3.30E+00**	**4.28E+02**	**NA**	**3.90E+01**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-23-5	Sodium	6.25E+02		4.23E+03		mg/kg	MW-17-0.0-0.5	5/6	0.00E+00 - 4.49E+02	4.23E+03	NA	NA		NA	NA	No	NUT
7440-62-2	Vanadium	3.40E+00		2.13E+01	J	mg/kg	SO4-01-0.0-0.5	7/7	0.00E+00 - 0.00E+00	2.13E+01	NA	3.90E+01	N	NA	NA	No	BSL
7440-66-6	Zinc	7.18E+01		5.60E+02		mg/kg	SO4-01-0.0-0.5	7/7	0.00E+00 - 0.00E+00	5.60E+02	NA	2.30E+03	N	NA	NA	No	BSL
							PAH										
83-32-9	Acenaphthene	5.10E-03	LJ	3.20E-02	LJ	mg/kg	SO4-04-0.0-0.5	3/6	0.00E+00 - 7.30E-02	3.20E-02	NA	3.40E+02	N	NA	NA	No	BSL
208-96-8	Acenaphthylene	7.30E-03	LJ	6.10E-02	LJ	mg/kg	SO4-04-0.0-0.5	4/6	0.00E+00 - 7.20E-02	6.10E-02	NA	3.60E+00	C	NA	NA	No	BSL
120-12-7	Anthracene	1.30E-02	LJ	6.50E-02	LJ	mg/kg	SO4-04-0.0-0.5	5/6	0.00E+00 - 7.20E-02	6.50E-02	NA	1.70E+03	N	NA	NA	No	BSL
56-55-3	**Benzo(a)anthracene**	**6.30E-02**		**5.90E-01**		**mg/kg**	**MW-17-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**5.90E-01**	**NA**	**1.50E-01**	**C**	**NA**	**NA**	**Yes**	**ASL**
50-32-8	**Benzo(a)pyrene**	**5.30E-02**		**5.00E-01**		**mg/kg**	**MW-17-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**5.00E-01**	**NA**	**1.50E-02**	**C**	**NA**	**NA**	**Yes**	**ASL**
205-99-2	**Benzo(b)fluoranthene**	**1.00E-01**		**8.20E-01**		**mg/kg**	**MW-17-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**8.20E-01**	**NA**	**1.50E-01**	**C**	**NA**	**NA**	**Yes**	**ASL**
191-24-2	Benzo(g,h,i)perylene	2.20E-02		2.19E-01		mg/kg	FR-133A	7/7	0.00E+00 - 0.00E+00	2.19E-01	NA	1.70E+02	N	NA	NA	No	BSL
207-08-9	Benzo(k)fluoranthene	2.80E-02		2.70E-01		mg/kg	SO4-04-0.0-0.5	7/7	0.00E+00 - 0.00E+00	2.70E-01	NA	1.50E+00	C	NA	NA	No	BSL
218-01-9	Chrysene	7.00E-02		6.00E-01		mg/kg	MW-17-0.0-0.5	7/7	0.00E+00 - 0.00E+00	6.00E-01	NA	1.50E+01	C	NA	NA	No	BSL
53-70-3	**Dibenz(a,h)anthracene**	**1.00E-02**		**7.60E-02**		**mg/kg**	**MW-17-0.0-0.5**	**5/6**	**0.00E+00 - 7.20E-02**	**7.60E-02**	**NA**	**1.50E-02**	**C**	**NA**	**NA**	**Yes**	**ASL**
206-44-0	Fluoranthene	1.60E-01		1.40E+00		mg/kg	MW-17-0.0-0.5	7/7	0.00E+00 - 0.00E+00	1.40E+00	NA	2.30E+02	N	NA	NA	No	BSL
86-73-7	Fluorene	3.70E-03	LJ	1.50E-02	LJ	mg/kg	MW-17-0.0-0.5	2/6	0.00E+00 - 7.40E-02	1.50E-02	NA	2.30E+02	N	NA	NA	No	BSL
193-39-5	**Indeno(1,2,3-cd)pyrene**	**5.00E-02**		**3.50E-01**		**mg/kg**	**SO4-04-0.0-0.5, MW-17-0.0-0.5**	**7/7**	**0.00E+00 - 0.00E+00**	**3.50E-01**	**NA**	**1.50E-01**	**C**	**NA**	**NA**	**Yes**	**ASL**
85-01-8	Phenanthrene	4.30E-02	LJ	1.66E+02	J	mg/kg	FR-133A	7/7	0.00E+00 - 0.00E+00	1.66E+02	NA	1.70E+03	N	NA	NA	No	BSL
129-00-0	Pyrene	1.20E-01		1.10E+00		mg/kg	MW-17-0.0-0.5	7/7	0.00E+00 - 0.00E+00	1.10E+00	NA	1.70E+02	N	NA	NA	No	BSL
							SVOC										
98-86-2	Acetophenone	6.20E-02	LJ	6.20E-02	LJ	mg/kg	SO4-05-0.0-0.5	1/6	0.00E+00 - 1.20E+00	6.20E-02	NA	7.80E+02	N	NA	NA	No	BSL
100-52-7	Benzaldehyde	6.60E-02	LJ	6.60E-02	LJ	mg/kg	SO4-05-0.0-0.5	1/6	0.00E+00 - 1.20E+00	6.60E-02	NA	7.80E+02	N	NA	NA	No	BSL
117-81-7	Bis(2-ethylhexyl) phthalate	9.40E-02	LJ	2.20E-01	LJ	mg/kg	SO4-04-0.0-0.5	3/7	0.00E+00 - 1.20E+00	2.20E-01	NA	3.50E+01	C	NA	NA	No	BSL
86-74-8	Carbazole	1.90E-02	LJ	1.90E-02	LJ	mg/kg	SO4-05-0.0-0.5	1/6	0.00E+00 - 1.20E+00	1.90E-02	NA	NA		NA	NA	No	NSL
131-11-3	Dimethyl phthalate	2.00E-02	LJ	1.50E-01	LJ	mg/kg	SO4-04-0.0-0.5	2/6	0.00E+00 - 1.20E+00	1.50E-01	NA	NA		NA	NA	No	NSL
108-95-2	Phenol	3.30E-02	LJ	3.30E-02	LJ	mg/kg	SO4-05-0.0-0.5	1/6	0.00E+00 - 1.20E+00	3.30E-02	NA	1.80E+03	N	NA	NA	No	BSL
							VOC										
78-93-3	2-Butanone (Methyl ethyl ketone)	1.40E-02	LJ	1.40E-02	LJ	mg/kg	SO4-01-0.0-0.5	1/6	0.00E+00 - 1.20E-02	1.40E-02	NA	2.80E+03	N	NA	NA	No	BSL
100-41-4	Ethylbenzene	3.70E-03	LJ	3.70E-03	LJ	mg/kg	SO4-01-0.0-0.5	1/6	0.00E+00 - 5.90E-03	3.70E-03	NA	5.40E+00	C	NA	NA	No	BSL
98-82-8	Isopropylbenzene (Cumene)	3.30E-04	LJ	2.30E-03	J	mg/kg	FR-133A	2/7	0.00E+00 - 5.90E-03	2.30E-03	NA	2.10E+02	N	NA	NA	No	BSL
179601-23-1	m- & p-Xylenes	1.50E-04	LJ	3.50E-02	J	mg/kg	SO4-01-0.0-0.5	2/6	0.00E+00 - 5.90E-03	3.50E-02	NA	NA		NA	NA	No	NSL
95-47-6	o-Xylene	1.20E-02		1.20E-02		mg/kg	SO4-01-0.0-0.5	1/6	0.00E+00 - 5.90E-03	1.20E-02	NA	6.90E+01	N	NA	NA	No	BSL
79-01-6	Trichloroethene (TCE)	1.20E-03	LJ	1.20E-03	LJ	mg/kg	SO4-01-0.0-0.5	1/6	0.00E+00 - 5.90E-03	1.20E-03	NA	4.40E-01	N	NA	NA	No	BSL
75-69-4	Trichlorofluoromethane	2.30E-04	LJ	5.00E-04	LJ	mg/kg	SO4-01-0.0-0.5	4/6	0.00E+00 - 5.10E-03	5.00E-04	NA	7.90E+01	N	NA	NA	No	BSL

TABLE 1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
AOC-4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL - RESIDENTIAL
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future-Residential
Medium: Surface soil
Exposure Medium: Surface soil
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value	Potential (5) ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (6) Contaminant Deletion or Selection

NOTES:
(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) Screening Toxicity Value - Taken from State of Maryland Department of the Environment Residential Cleanup Standard for Soil, June 2008.

(5) USEPA Regional Screening Levels, USEPA, November 2013. For non-carcinogens, value shown is equal to 1/10 the residential soil value. For carcinogens the value shown is equal to the residential soil value.
(6) Rationale Codes
Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Toxicity Level
NUT = Essential Nutrient

Definitions:
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable

mg/kg = milligrams per kilogram

Data Qualifiers:
B = Indicates a metal value below the Reporting Limit
J = Indicates a value below the Reporting Limit
L = Indicates a potential for low bias in the result

Surrogates used: Chromium(III) for Chromium, Methyl Mercury for Mercury, Anthracene for Phenanthrene, Naphthalene for Acenaphthylene, Pyrene for Benzo(g,h,i)perylene.

TABLE 2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
AOC-4, FALCON REFINERY SUPERFUND SITE - SUBSURFACE SOIL - RESIDENTIAL
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future-Residential
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value	Potential (5) ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (6) Contaminant Deletion or Selection
							Inorganics									
7429-90-5	Aluminum	8.18E+02		3.79E+03		mg/kg	FR-135	12/12	0.00E+00 - 0.00E+00	3.79E+03	NA	7.70E+03 N	NA	NA	No	BSL
7440-38-2	**Arsenic**	**4.10E-01**	**LJ**	**2.10E+00**		**mg/kg**	**MW-17-0.5-2.0**	**12/12**	**0.00E+00 - 0.00E+00**	**2.10E+00**	**NA**	**6.10E-01 C**	**NA**	**NA**	**Yes**	**ASL**
7440-39-3	Barium	5.30E+00		2.03E+02		mg/kg	SO4-01-0.5-2.0	12/12	0.00E+00 - 0.00E+00	2.03E+02	NA	1.50E+03 N	NA	NA	No	BSL
7440-41-7	Beryllium	2.40E-01	B	2.40E-01	B	mg/kg	FR-135	1/12	0.00E+00 - 5.40E-01	2.40E-01	NA	1.60E+01 N	NA	NA	No	BSL
7440-70-2	Calcium	5.74E+02		1.46E+05	J	mg/kg	SO4-03-0.5-2.0	11/11	0.00E+00 - 0.00E+00	1.46E+05	NA	NA	NA	NA	No	NUT
7440-47-3	Chromium	5.80E-01	LJ	4.40E+00		mg/kg	FR-135	12/12	0.00E+00 - 0.00E+00	4.40E+00	NA	1.20E+04 N	NA	NA	No	BSL
7440-48-4	Cobalt	4.70E-01		9.70E-01		mg/kg	MW-17-0.5-2.0	8/12	0.00E+00 - 5.40E-01	9.70E-01	NA	2.30E+00 N	NA	NA	No	BSL
7440-50-8	Copper	5.90E-01	LJ	4.10E+00		mg/kg	SO4-01-0.5-2.0	9/12	0.00E+00 - 1.10E+00	4.10E+00	NA	3.10E+02 N	NA	NA	No	BSL
7439-89-6	Iron	7.61E+02	J	3.13E+03		mg/kg	SO4-05-2.0-3.0	12/12	0.00E+00 - 0.00E+00	3.13E+03	NA	5.50E+03 N	NA	NA	No	BSL
7439-92-1	Lead	7.70E-01		1.58E+01		mg/kg	MW-17-2.0-3.5	12/12	0.00E+00 - 0.00E+00	1.58E+01	NA	4.00E+02	NA	NA	No	BSL
7439-95-4	Magnesium	1.88E+02	LJ	2.09E+03		mg/kg	SO4-05-2.0-3.0	11/11	0.00E+00 - 0.00E+00	2.09E+03	NA	NA	NA	NA	No	NUT
7439-96-5	Manganese	7.50E+00		1.20E+02	J	mg/kg	SO4-03-0.5-2.0	12/12	0.00E+00 - 0.00E+00	1.20E+02	NA	1.80E+02 N	NA	NA	No	BSL
7439-97-6	**Mercury**	**6.00E-03**	**LJ**	**2.30E+00**	**J**	**mg/kg**	**SO4-02-0.5-2.0**	**11/12**	**0.00E+00 - 1.10E-01**	**2.30E+00**	**NA**	**1.00E+00 N**	**NA**	**NA**	**Yes**	**ASL**
7440-02-0	Nickel	3.40E-01	LJ	1.80E+00		mg/kg	SO4-05-2.0-3.0	12/12	0.00E+00 - 0.00E+00	1.80E+00	NA	1.50E+02 N	NA	NA	No	BSL
7440-09-7	Potassium	3.02E+02	LJ	1.11E+03		mg/kg	SO4-05-2.0-3.0	9/11	0.00E+00 - 4.63E+02	1.11E+03	NA	NA	NA	NA	No	NUT
7782-49-2	Selenium	2.90E-01	B	2.90E-01	B	mg/kg	FR-135	1/12	0.00E+00 - 2.70E+00	2.90E-01	NA	3.90E+01 N	NA	NA	No	BSL
7440-23-5	Sodium	3.21E+02	LJ	1.33E+03		mg/kg	MW-17-0.5-2.0	10/11	0.00E+00 - 4.08E+02	1.33E+03	NA	NA	NA	NA	No	NUT
7440-62-2	Vanadium	1.60E+00	LJ	5.70E+00	B	mg/kg	FR-135	10/12	0.00E+00 - 2.60E+00	5.70E+00	NA	3.90E+01 N	NA	NA	No	BSL
7440-66-6	Zinc	4.20E+00		7.91E+01		mg/kg	SO4-02-0.5-2.0	11/12	0.00E+00 - 9.60E-01	7.91E+01	NA	2.30E+03 N	NA	NA	No	BSL
							PAH									
91-57-6	2-Methylnaphthalene	1.90E-03	LJ	1.90E-03	LJ	mg/kg	MW-17-0.5-2.0	1/11	0.00E+00 - 1.10E-01	1.90E-03	NA	2.30E+01 N	NA	NA	No	BSL
83-32-9	Acenaphthene	1.30E-02		1.10E-01		mg/kg	SO4-04-2.0-3.0	2/11	0.00E+00 - 1.10E-01	1.10E-01	NA	3.40E+02 N	NA	NA	No	BSL
208-96-8	Acenaphthylene	2.70E-03	LJ	1.20E-02	LJ	mg/kg	SO4-04-2.0-3.0	6/11	0.00E+00 - 1.10E-01	1.20E-02	NA	3.60E+00 C	NA	NA	No	BSL
120-12-7	Anthracene	1.60E-03	LJ	1.30E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	1.30E-01	NA	1.70E+03 N	NA	NA	No	BSL
56-55-3	**Benzo(a)anthracene**	**4.50E-03**		**2.30E-01**		**mg/kg**	**SO4-05-0.5-2.0**	**9/11**	**0.00E+00 - 4.00E-03**	**2.30E-01**	**NA**	**1.50E-01 C**	**NA**	**NA**	**Yes**	**ASL**
50-32-8	**Benzo(a)pyrene**	**3.30E-03**	**LJ**	**2.50E-01**		**mg/kg**	**SO4-05-0.5-2.0**	**9/11**	**0.00E+00 - 4.00E-03**	**2.50E-01**	**NA**	**1.50E-02 C**	**NA**	**NA**	**Yes**	**ASL**
205-99-2	**Benzo(b)fluoranthene**	**4.80E-03**		**2.80E-01**		**mg/kg**	**SO4-05-0.5-2.0**	**9/11**	**0.00E+00 - 4.00E-03**	**2.80E-01**	**NA**	**1.50E-01 C**	**NA**	**NA**	**Yes**	**ASL**
191-24-2	Benzo(g,h,i)perylene	1.70E-03	LJ	8.90E-02	LJ	mg/kg	SO4-05-0.5-2.0	8/11	0.00E+00 - 4.00E-03	8.90E-02	NA	1.70E+02 N	NA	NA	No	BSL
207-08-9	Benzo(k)fluoranthene	1.70E-03	LJ	1.30E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	1.30E-01	NA	1.50E+00 C	NA	NA	No	BSL
218-01-9	Chrysene	4.20E-03		2.10E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	2.10E-01	NA	1.50E+01 C	NA	NA	No	BSL
53-70-3	**Dibenz(a,h)anthracene**	**2.00E-03**	**LJ**	**2.80E-02**		**mg/kg**	**MW-17-0.5-2.0**	**6/11**	**0.00E+00 - 1.10E-01**	**2.80E-02**	**NA**	**1.50E-02 C**	**NA**	**NA**	**Yes**	**ASL**
206-44-0	Fluoranthene	8.70E-03		4.80E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	4.80E-01	NA	2.30E+02 N	NA	NA	No	BSL
86-73-7	Fluorene	7.60E-03		7.60E-03		mg/kg	MW-17-0.5-2.0	1/11	0.00E+00 - 1.10E-01	7.60E-03	NA	2.30E+02 N	NA	NA	No	BSL
193-39-5	**Indeno(1,2,3-cd)pyrene**	**2.50E-03**	**LJ**	**2.00E-01**		**mg/kg**	**SO4-05-0.5-2.0**	**9/11**	**0.00E+00 - 4.00E-03**	**2.00E-01**	**NA**	**1.50E-01 C**	**NA**	**NA**	**Yes**	**ASL**
91-20-3	Naphthalene	1.90E-03	LJ	2.50E-03	LJ	mg/kg	MW-17-0.5-2.0	2/11	0.00E+00 - 1.10E-01	2.50E-03	NA	3.60E+00 C	NA	NA	No	BSL
85-01-8	Phenanthrene	6.60E-03		3.00E-01		mg/kg	SO4-05-0.5-2.0	8/11	0.00E+00 - 7.30E-03	3.00E-01	NA	1.70E+03 N	NA	NA	No	BSL
129-00-0	Pyrene	9.00E-03		3.80E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	3.80E-01	NA	1.70E+02 N	NA	NA	No	BSL
							SVOC									
98-86-2	Acetophenone	2.00E-02	LJ	7.80E-02	LJ	mg/kg	SO4-05-0.5-2.0	5/11	0.00E+00 - 1.00E+00	7.80E-02	NA	7.80E+02 N	NA	NA	No	BSL
100-52-7	Benzaldehyde	2.30E-02	LJ	7.40E-02	LJ	mg/kg	SO4-05-0.5-2.0	5/11	0.00E+00 - 1.00E+00	7.40E-02	NA	7.80E+02 N	NA	NA	No	BSL
117-81-7	Bis(2-ethylhexyl) phthalate	2.20E-02	LJ	1.33E-01	J	mg/kg	FR-135	2/12	0.00E+00 - 1.00E+00	1.33E-01	NA	3.50E+01 C	NA	NA	No	BSL
86-74-8	Carbazole	2.60E-02	LJ	3.20E-02	LJ	mg/kg	MW-17-0.5-2.0	2/11	0.00E+00 - 1.00E+00	3.20E-02	NA	NA	NA	NA	No	BSL
131-11-3	Dimethyl phthalate	2.20E-02	LJ	2.20E-02	LJ	mg/kg	MW-17-2.0-3.5	1/11	0.00E+00 - 1.00E+00	2.20E-02	NA	NA	NA	NA	No	BSL
							VOC									
67-64-1	Acetone	6.00E-03	LJ	9.10E-03	J	mg/kg	FR-135	5/12	0.00E+00 - 1.50E-02	9.10E-03	NA	6.10E+03 N	NA	NA	No	BSL
75-15-0	Carbon disulfide	3.90E-04	LJ	3.90E-04	LJ	mg/kg	SO4-01-2.0-3.0	1/11	0.00E+00 - 7.70E-03	3.90E-04	NA	8.20E+01 N	NA	NA	No	BSL
67-66-3	Chloroform	5.50E-04	LJ	5.50E-04	LJ	mg/kg	SO4-04-2.0-3.0	1/11	0.00E+00 - 7.70E-03	5.50E-04	NA	2.90E-01 C	NA	NA	No	BSL
179601-23-1	m- & p-Xylenes	1.40E-04	LJ	6.70E-04	LJ	mg/kg	SO4-04-0.5-2.0	5/11	0.00E+00 - 6.20E-03	6.70E-04	NA	NA	NA	NA	No	BSL
75-09-2	Methylene chloride	3.50E-03	J	3.50E-03	J	mg/kg	FR-135	1/12	0.00E+00 - 7.70E-03	3.50E-03	NA	3.60E+01 N	NA	NA	No	BSL
1634-04-4	Methyl-tertiary-butyl ether (MtBE)	9.60E-04	LJ	9.60E-04	LJ	mg/kg	SO4-05-2.0-3.0	1/11	0.00E+00 - 7.70E-03	9.60E-04	NA	4.30E+01 C	NA	NA	No	BSL
75-69-4	Trichlorofluoromethane	1.40E-04	LJ	3.50E-04	LJ	mg/kg	SO4-01-0.5-2.0	8/11	0.00E+00 - 6.20E-03	3.50E-04	NA	7.90E+01 N	NA	NA	No	BSL

TABLE 2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
AOC-4, FALCON REFINERY SUPERFUND SITE - SUBSURFACE SOIL - RESIDENTIAL
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future-Residential
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value	Potential (5) ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (6) Contaminant Deletion or Selection

NOTES:
(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) Screening Toxicity Value - Taken from State of Maryland Department of the Environment Residential Cleanup Standard for Soil, June 2008.
(5) USEPA Regional Screening Levels, USEPA, November 2013. For non-carcinogens, value shown is equal to 1/10 the residential soil value. For carcinogens the value shown is equal to the residential soil value.
(6) Rationale Codes
Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Toxicity Level
NUT = Essential Nutrient

Definitions:
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
mg/kg = milligrams per kilogram

Data Qualifiers:
B = Indicates analyte detected in associated method blank
J = Indicates an estimated value

Surrogates used: Chromium(III) for Chromium, Methyl Mercury for Mercury, Anthracene for Phenanthrene, Naphthalene for Acenaphthylene, Pyrene for Benzo(g,h,i)perylene.

TABLE 3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
AOC-4, FALCON REFINERY SUPERFUND SITE - GROUND WATER
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Current
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential (5) ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (6) Contaminant Deletion or Selection
									INORGANICS-DISSOLVED								
7440-38-2	**Arsenic**	**6.08E+01**		**6.08E+01**		**ug/L**	**MW-17**	**1/1**	**0.00E+00 - 0.00E+00**	**6.08E+01**	**NA**	**4.50E-02**	**C**	**1.00E+01**	**MCL**	**Yes**	**ASL**
7440-39-3	Barium	1.24E+02		1.24E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.24E+02	NA	2.90E+02	N	2.00E+03	MCL	No	BSL
7440-70-2	Calcium	8.04E+04		8.04E+04		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	8.04E+04	NA	NA		NA	NA	No	NUT
7439-89-6	Iron	3.19E+02		3.19E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	3.19E+02	NA	1.10E+03	N	NA	NA	No	BSL
7439-95-4	Magnesium	1.28E+05		1.28E+05		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.28E+05	NA	NA		NA	NA	No	NUT
7439-96-5	**Manganese**	**1.33E+02**		**1.33E+02**		**ug/L**	**MW-17**	**1/1**	**0.00E+00 - 0.00E+00**	**1.33E+02**	**NA**	**3.20E+01**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-02-0	Nickel	5.80E+00		5.80E+00		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	5.80E+00	NA	3.00E+01	N	NA	NA	No	BSL
7440-09-7	Potassium	1.07E+05		1.07E+05		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.07E+05	NA	NA		NA	NA	No	NUT
7440-23-5	Sodium	1.47E+06		1.47E+06		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.47E+06	NA	NA		NA	NA	No	NUT
									INORGANICS-TOTAL								
7429-90-5	Aluminum	1.65E+02	LJ	1.65E+02	LJ	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.65E+02	NA	1.60E+03	N	NA	NA	No	BSL
7440-38-2	**Arsenic**	**6.04E+01**		**6.04E+01**		**ug/L**	**MW-17**	**1/1**	**0.00E+00 - 0.00E+00**	**6.04E+01**	**NA**	**4.50E-02**	**C**	**1.00E+01**	**MCL**	**Yes**	**ASL**
7440-39-3	Barium	1.24E+02		1.24E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.24E+02	NA	2.90E+02	N	2.00E+03	MCL	No	BSL
7440-70-2	Calcium	9.13E+04		9.13E+04		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	9.13E+04	NA	NA		NA	NA	No	NUT
7439-89-6	Iron	4.79E+02		4.79E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	4.79E+02	NA	1.10E+03	N	NA	NA	No	BSL
7439-95-4	Magnesium	1.21E+05		1.21E+05		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.21E+05	NA	NA		NA	NA	No	NUT
7439-96-5	**Manganese**	**1.34E+02**		**1.34E+02**		**ug/L**	**MW-17**	**1/1**	**0.00E+00 - 0.00E+00**	**1.34E+02**	**NA**	**3.20E+01**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-02-0	Nickel	4.20E+00	LJ	4.20E+00	LJ	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	4.20E+00	NA	3.00E+01	N	NA	NA	No	BSL
7440-09-7	Potassium	1.16E+05		1.16E+05		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.16E+05	NA	NA		NA	NA	No	NUT
7782-49-2	Selenium	2.90E+00	LJ	2.90E+00	LJ	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	2.90E+00	NA	7.80E+00	N	5.00E+01	MCL	No	BSL
7440-23-5	Sodium	1.29E+06	J	1.29E+06	J	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.29E+06	NA	NA		NA	NA	No	NUT
									VOC								
106-46-7	1,4-Dichlorobenzene	1.40E-01	LJ	1.40E-01	LJ	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.40E-01	NA	4.20E-01	C	7.50E+01	MCL	No	BSL

NOTES:
(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) Screening Toxicity Value - Taken from State of Maryland Department of the Environment Residential Cleanup Standard for Soil, June 2008.
(5) USEPA Regional Screening Levels, USEPA, November 2013. For non-carcinogens, value shown is equal to 1/10 the tap water value. For carcinogens the value shown is equal to the tap water value.
(6) Rationale Codes
Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Toxicity Level
NUT = Essential Nutrient

Definitions:
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
ug/L = micrograms per liter

Data Qualifiers: J = Indicates an estimated value

TABLE 4
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
AOC-4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL - RESIDENTIAL
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Current/Future-Residential
Medium: Surface soil
Exposure Medium: Surface soil
Exposure Point: Falcon Refinery

Chemical of Potential Concern	Units	Mean Detected Concentration	95% UCLM	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS									
Aluminum	mg/kg	4.87E+03	1.38E+04	1.70E+04		mg/kg	1.38E+04	95%UCLM-C	ProUCL
Arsenic	mg/kg	2.31E+00	3.85E+00	5.70E+00		mg/kg	3.85E+00	95%UCLM-G	ProUCL
Cobalt	mg/kg	1.49E+00	2.50E+00	3.80E+00		mg/kg	2.50E+00	95%UCLM-G	ProUCL
Iron	mg/kg	5.26E+03	8.05E+03	1.30E+04		mg/kg	8.05E+03	95%UCLM-N	ProUCL
Lead	mg/kg	8.36E+01	4.87E+03	4.84E+02		mg/kg	8.36E+01	Mean	USEPA 1994
Manganese	mg/kg	1.23E+02	1.79E+02	2.59E+02	J	mg/kg	1.79E+02	95%UCLM-G	ProUCL
Mercury	mg/kg	5.31E-01	1.04E+00	1.50E+00		mg/kg	1.04E+00	95%UCLM-G	ProUCL
Selenium	mg/kg	NA	NA	4.28E+02	B	mg/kg	4.28E+02	Maximum	LOW %DETECTS
PAH									
Benzo(a)anthracene	mg/kg	2.25E-01	4.90E-01	5.90E-01		mg/kg	4.90E-01	95%UCLM-G	ProUCL
Benzo(a)pyrene	mg/kg	2.16E-01	4.38E-01	5.00E-01		mg/kg	4.38E-01	95%UCLM-G	ProUCL
Benzo(b)fluoranthene	mg/kg	3.66E-01	7.25E-01	8.20E-01		mg/kg	7.25E-01	95%UCLM-G	ProUCL
Dibenz(a,h)anthracene	mg/kg	4.72E-02	6.98E-02	7.60E-02		mg/kg	6.98E-02	95%UCLM-KMt	ProUCL
Indeno(1,2,3-cd)pyrene	mg/kg	1.78E-01	2.69E-01	3.50E-01		mg/kg	2.69E-01	95%UCLM-N	ProUCL

NOTES: Statistics calculated by the EPA program ProUCL.
95%UCLM-C indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Chebyshev test.
95%UCLM-G indicates that the 95 percent upper confidence limit on the mean is based on the approximate or adjusted gamma distribution.
95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.
LOW %DETECTS indicates low percentage of detects.
USEPA 1994 = The arithmetic mean is used per USEPA lead model guidance (USEPA 1994).
NA = Not Applicable

TABLE 5
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
AOC-4, FALCON REFINERY SUPERFUND SITE - SUBSURFACE SOIL - RESIDENTIAL
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Current/Future-Residential
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Falcon Refinery

Chemical of Potential Concern	Units	Mean Detected Concentration	95% UCLM	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS									
Arsenic	mg/kg	1.02E+00	1.27E+00	2.10E+00		mg/kg	1.36E+00	95%UCLM-N	ProUCL
Mercury	mg/kg	2.58E-01	2.12E+00	2.30E+00	J	mg/kg	2.12E+00	95%UCLM-KMC	ProUCL
PAH									
Benzo(a)anthracene	mg/kg	6.18E-02	1.56E-01	2.30E-01		mg/kg	1.56E-01	95%UCLM-KMC	ProUCL
Benzo(a)pyrene	mg/kg	6.04E-02	1.53E-01	2.50E-01		mg/kg	1.53E-01	95%UCLM-KMC	ProUCL
Benzo(b)fluoranthene	mg/kg	9.43E-02	2.16E-01	2.80E-01		mg/kg	2.16E-01	95%UCLM-KMC	ProUCL
Dibenz(a,h)anthracene	mg/kg	9.63E-03	1.18E-02	2.80E-02		mg/kg	1.18E-02	95%UCLM-KMp	ProUCL
Indeno(1,2,3-cd)pyrene	mg/kg	4.99E-02	1.22E-01	2.00E-01		mg/kg	1.22E-01	95%UCLM-KMC	ProUCL

NOTES: Statistics calculated by the EPA program ProUCL.
95%UCLM-KMC indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) Chebyshev test.
95%UCLM-KMp indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) percentile boostrap test.
95%UCLM-N indicates that the 95 percent upper confidence limit on the mean is based on the student's t-test for normal distributions.

TABLE 6
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
AOC-4, FALCON REFINERY SUPERFUND SITE - GROUND WATER - RESIDENTIAL
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Falcon Refinery

Chemical of Potential Concern	Units	Mean Detected Concentration	95% UCLM	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS-DISSOLVED									
Arsenic	ug/L	NA	NA	6.08E+01		ug/L	6.08E+01	Maximum	N < 5
Manganese	ug/L	NA	NA	1.33E+02		ug/L	1.33E+02	Maximum	N < 5
INORGANICS-TOTAL									
Arsenic	ug/L	NA	NA	6.04E+01		ug/L	6.04E+01	Maximum	N < 5
Manganese	ug/L	NA	NA	1.34E+02		ug/L	1.34E+02	Maximum	N < 5

NOTES:
N < 5 indicates that the number of samples is less than 5, so the maximum detected value was used.
NA = Not Applicable

TABLE 7
VALUES USED FOR RESIDENT ADULT DAILY SOIL INTAKE EQUATIONS
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: AOC-4
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	Chronic Daily Intake (CDI) (mg/kg/day) =
	CR	Ingestion Rate	mg/day	100	U.S. EPA 1991a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991a	
	ED-C	Exposure Duration-Cancer	yr	24	U.S. EPA 1991a	
	BW	Body Weight	kg	70	U.S. EPA 1989	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	AT-NC	Averaging time - Noncancer	days	10,950	U.S. EPA 1989	CS x EF x ([(ED_{6-16} x CR x 3) + (ED_{16-30} x CR x 1)]/BW) x CF / (AT)
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	5,700	U.S. EPA 2004 (1)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.07	U.S. EPA 2004 (1)	
	EF	Exposure Frequency	event/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991a	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	BW	Body Weight	kg	70	U.S. EPA 1991a	CS x EF x ABS x ([(ED_{6-16} x SA x AF x 3) + (ED_{16-30} x SA x AF x 1)]/BW) x CF / (AT)
	AT-NC	Averaging time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (2)	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration ($\mu g/m^3$ or mg/m^3) =
	CF_1	Conversion Factor	µg/mg	1,000	U.S. EPA 2009a	CA x CF_1 x ET x EF x ED / AT x CF_2
	ET	Exposure Time	hr/day	24	U.S. EPA 2009a	Note: CF_1 only used in carcinogenic intake calculations
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991a	
	BW	Body Weight	kg	70	U.S. EPA 1989	Mutagenic Exposure Concentration (MEC) ($\mu g/m^3$) =
	AT-NC	Averaging time - Noncancer	days	10,950	U.S. EPA 1989	CA x ET x EF x [(ED_{6-16} x 3) + (ED_{16-30} x 1)] x CF_1 / (AT x CF_2)
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF_2	Conversion Factor	hour/day	24	U.S. EPA 2009a	

NOTES:
(1) Taken from Exhibit 3-5 of USEPA 2004.
(2) Taken from Exhibit 3-4 of USEPA 2004.

BPJ = Best Professional Judgment
U.S. EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 8
VALUES USED FOR RESIDENT CHILD DAILY SOIL INTAKE EQUATIONS
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: AOC-4
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	Chronic Daily Intake (CDI) (mg/kg/day) =
	CR	Ingestion Rate	mg/day	200	U.S. EPA 2011a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S. EPA 1991a	
	ED-C	Exposure Duration-Cancer	yr	6	U.S. EPA 1991a	
	BW	Body Weight	kg	15	U.S. EPA 1989	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	AT-NC	Averaging time - Noncancer	days	2,190	U.S. EPA 1989	CS x EF x ([(ED_{0-2} x CR x 10) + (ED_{2-6} x CR x 3)]/BW) x CF / (AT)
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	2,800	U.S. EPA 2004 (1)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.2	U.S. EPA 2004 (1)	
	EF	Exposure Frequency	event/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	6	U.S. EPA 1991a	
	BW	Body Weight	kg	15	U.S. EPA 1989	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	AT-NC	Averaging time - Noncancer	days	2,190	U.S. EPA 1989	CS x EF x ABS x ([(ED_{0-2} x SA x AF x 10) + (ED_{2-6} x SA x AF x 3)]/BW) x CF / (AT)
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (2)	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration ($\mu g/m^3$ or mg/m^3) =
	CF_1	Conversion Factor	µg/mg	1,000	U.S. EPA 2009a	CA x CF_1 x ET x EF x ED / AT x CF_2
	ET	Exposure Time	hr/day	24	U.S. EPA 2009a	Note: CF_1 only used in carcinogenic intake calculations
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	6	U.S. EPA 1991a	
	BW	Body Weight	kg	15	U.S. EPA 1989	Mutagenic Exposure Concentration (MEC) ($\mu g/m^3$) =
	AT-NC	Averaging time - Noncancer	days	2,190	U.S. EPA 1989	CA x ET x EF x [(ED_{0-2} x 10) + (ED_{2-6} x 3)] x CF_1 / (AT x CF_2)
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF_2	Conversion Factor	hour/day	24	U.S. EPA 2009a	

NOTES:
(1) Taken from Exhibit 3-5 of USEPA 2004.
(2) Taken from Exhibit 3-4 of USEPA 2004.

BPJ = Best Professional Judgment
U.S. EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 9
VALUES USED FOR CONSTRUCTION WORKER DAILY SOIL INTAKE EQUATIONS
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: AOC-4
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	330	U.S. EPA 1991a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991a	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,300	U.S. EPA 2004 (2)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.2	U.S. EPA 2004 (2)	
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991a	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (3)	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration ($\mu g/m^3$ or mg/m^3) =
	CF_1	Conversion Factor	µg/mg	1,000	U.S. EPA 2009a	CA x CF_1 x ET x EF x ED / AT x CF_2
	ET	Exposure Time	hr/day	8	U.S. EPA 2009a	Note: CF_1 only used in carcinogenic intake calculations
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991a	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF_2	Conversion Factor	hour/day	24	U.S. EPA 2009a	

NOTES:
(1) Construction events are assumed to extend for up to one year total in duration.
(2) Taken from Exhibit 3-5 of USEPA 2004.
(3) Taken from Exhibit 3-4 of USEPA 2004.

BPJ = Best Professional Judgment
U.S. EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 10
NON-CANCER TOXICITY DATA - ORAL/DERMAL
AOC 4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Constituents of Potential Concern	Chronic/ Subchronic	Oral RfD Value (mg/kg-day)	Oral to Dermal Adjustment Factor (GI ABS) (1)	Adjusted Dermal RfD (2) (mg/kg bw-day)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (mm/dd/yy)
Inorganics								
ALUMINUM	Chronic	1.0E+00	1	1.0E+00	Central Nervous System	100/1	PPRTV	10/23/2006
ARSENIC	Chronic	3.0E-04	1	3.0E-04	Skin	3/1	IRIS	3/10/2014
COBALT	Chronic	3.0E-04	1	3.0E-04	Thyroid	3000/1	PPTRV	8/25/2008
IRON	Chronic	7.0E-01	1	7.0E-01	Gastrointestinal System	1.5/1	PPRTV	9/11/2006
MANGANESE	Chronic	4.7E-02	0.04	1.9E-03	Central Nervous System	1/3	IRIS	3/10/2014
MERCURY	Chronic	1.0E-04	1	1.0E-04	Central Nervous System	10/1	IRIS	3/10/2014
SELENIUM	Chronic	5.0E-03	1	5.0E-03	Hair and Skin	3/1	IRIS	3/10/2014
PAHs								
BENZO(A)ANTHRACENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
BENZO(B)FLUORANTHENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
BENZO(A)PYRENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
DIBENZ(A,H)ANTHRACENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
INDENO(1,2,3-C,D)PYRENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014

NOTES:

NA = Not Available
RfD = Reference Dose
mg/kg-day = milligram per kilogram-day
GI ABS = Gastrointestinal Absorption Fraction
(1) Taken from USEPA 2004 Guidance.
(2) Dermal toxicological values adjusted from oral values using USEPA 2004 recommended chemical-specific gastrointestinal absorption factors (GI ABS). RfDs are multiplied by the GI ABS.
(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided. Available at: http://www.epa.gov/iris/
PPRTV - Provisional Peer-Reviewed Toxicity Value. For PPRTV values, the date of the issue paper is provided. Available at:http://hhpprtv.ornl.gov/

TABLE 11
NON-CANCER TOXICITY DATA - INHALATION
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Constituents of Potential Concern	Chronic/ Subchronic	Value Inhalation (RfC) (mg/m^3)	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC Target Organ	Dates [(1)] (mm/dd/yy)
Inorganics						
ALUMINUM	Chronic	5.0E-03	Respiratory System	300/1	PPRTV	10/23/2006
ARSENIC	Chronic	1.5E-05	Cardiovascular System	30/1	CalEPA	3/10/2014
COBALT	Chronic	6.0E-06	Respiratory System	300/1	PPRTV	8/25/2008
IRON	NA	NA	NA	NA	PPRTV	9/11/2006
MANGANESE	Chronic	5.0E-05	Central Nervous System	1000/1	IRIS	3/10/2014
MERCURY	Chronic	3.00E-04	Central Nervous System	30/1	IRIS	3/10/2014
SELENIUM	Chronic	2.00E-02	None	NA	IRIS	3/10/2014
PAHs						
BENZO(A)ANTHRACENE	NA	NA	NA	NA	IRIS	3/10/2014
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	IRIS	3/10/2014
BENZO(A)PYRENE	NA	NA	NA	NA	IRIS	3/10/2014
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	IRIS	3/10/2014
INDENO(1,2,3-C,D)PYRENE	NA	NA	NA	NA	IRIS	3/10/2014

NOTES:

NA = Not Available
RfC = Reference Concentration
mg/m^3 = milligrams per cubic meter
(1) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided. Available at: http://www.epa.gov/iris/
PPRTV - Provisional Peer-Reviewed Toxicity Value. For PPRTV values, the date of the issue paper is provided. Available at:http://hhpprtv.ornl.gov/
CalEPA - Calfornia Environmental Protection Agency. For CalEPA values, the date searched is provided.

TABLE 12
CHEMICAL-SPECIFIC PARAMETERS
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Constituents of Potential Concern	Absorption Factor	Reference	GI ABS	Reference
Inorganics				
ALUMINUM	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
ARSENIC	0.03	U.S. EPA, 2004	1	U.S. EPA, 2004
COBALT	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
IRON	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
MANGANESE	NA	U.S. EPA, 2004	0.04	U.S. EPA, 2004
MERCURY	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
SELENIUM	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
PAHs				
BENZO(A)ANTHRACENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
BENZO(B)FLUORANTHENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
BENZO(A)PYRENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
DIBENZ(A,H)ANTHRACENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
INDENO(1,2,3-C,D)PYRENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004

NOTES:
NA = Data not available.
GI ABS = Gastrointestional Absorption Fraction
U.S. EPA, 2004 = U.S. Environmental Protection Agency, 2004. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).* Final Guidance.

TABLE 13
CANCER TOXICITY DATA - ORAL/DERMAL
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Constituents of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor (GI ABS) (1)	Absorbed Cancer Slope Factor for Dermal (2)	Units	Weight of Evidence/Cancer Guideline Description	Mutagenic Compound	Source	Date (3) (mm/dd/yy)
Inorganics								
ALUMINUM	NA	1	NA	per (mg/kg-day)	D		PPRTV	10/23/2006
ARSENIC	1.5E+00	1	1.5E+00	per (mg/kg-day)	A		IRIS	3/10/2014
COBALT	NA	1	NA	per (mg/kg-day)	NA		PPTRV	8/25/2008
IRON	NA	1	NA	per (mg/kg-day)	NA		PPRTV	9/11/2006
MANGANESE	NA	0.04	NA	per (mg/kg-day)	D		IRIS	3/10/2014
MERCURY	NA	1	NA	per (mg/kg-day)	D		IRIS	3/10/2014
SELENIUM	NA	1	NA	per (mg/kg-day)	D		IRIS	3/10/2014
PAHs								
BENZO(A)ANTHRACENE	7.30E-01	1	7.30E-01	per (mg/kg-day)	B2	M	IRIS	3/10/2014
BENZO(B)FLUORANTHENE	7.30E-01	1	7.30E-01	per (mg/kg-day)	B2	M	IRIS	3/10/2014
BENZO(A)PYRENE	7.30E+00	1	7.30E+00	per (mg/kg-day)	B2	M	IRIS	3/10/2014
DIBENZ(A,H)ANTHRACENE	7.30E+00	1	7.30E+00	per (mg/kg-day)	B2	M	IRIS	3/10/2014
INDENO(1,2,3-C,D)PYRENE	7.30E-01	1	7.30E-01	per (mg/kg-day)	B2	M	IRIS	3/10/2014

NOTES:

NA = Not Available
mg/kg-day = milligram per kilogram-day
GI ABS = Gastrointestinal Absorption Fraction

(1) Taken from USEPA 2004 Guidance.
(2) Dermal Toxicological values adjusted from oral values using USEPA 2004 recommended chemical-specific gastrointestinal absorption factors (GI ABS). Cancer slope factors are divided by the GI ABS.
(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided. Available at: http://www.epa.gov/iris/
PPRTV - Provisional Peer-Reviewed Toxicity Value, the date of the issue paper is provided. Available at:http://hhpprtv.ornl.gov/

Weight of Evidence:
A - Human carcinogen
B1 - Probable human carcinogen - indicate that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 14
CANCER TOXICITY DATA - INHALATION
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Constituents of Potential Concern	Unit Risk		Weight of Evidence/Cancer Guideline Description	Mutagenic	Unit Risk	
	Value	Units			Source	Date [1]
Inorganics						
ALUMINUM	NA	per (ug/m^3)	D		PPRTV	10/23/2006
ARSENIC	4.3E-03	per (ug/m^3)	A		IRIS	3/10/2014
COBALT	9.0E-03	per (ug/m^3)	B2		PPTRV	8/25/2008
IRON	NA	per (ug/m^3)	NA		PPRTV	9/11/2006
MANGANESE	NA	per (ug/m^3)	D		IRIS	3/10/2014
MERCURY	NA	per (ug/m^3)	D		IRIS	3/10/2014
SELENIUM	NA	per (ug/m^3)	D		IRIS	3/10/2014
PAHs						
BENZO(A)ANTHRACENE	1.10E-04	per (ug/m^3)	B2	M	CalEPA	5/1/2009
BENZO(B)FLUORANTHENE	1.10E-04	per (ug/m^3)	B2	M	CalEPA	5/1/2009
BENZO(A)PYRENE	1.10E-03	per (ug/m^3)	B2	M	CalEPA	5/1/2009
DIBENZ(A,H)ANTHRACENE	1.10E-03	per (ug/m^3)	B2	M	CalEPA	5/1/2009
INDENO(1,2,3-C,D)PYRENE	1.10E-04	per (ug/m^3)	B2	M	CalEPA	5/1/2009

NOTES:
NA = Not Available
(1) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided. Available at: http://www.epa.gov/iris/
PPRTV - Provisional Peer-Reviewed Toxicity Value, the date of the issue paper is provided. Available at:http://hhpprtv.ornl.gov/
CalEPA - California Environmental Protection Agency, Cancer Potency Factors

Weight of Evidence: A - Human carcinogen
B1 - Probable human carcinogen - indicate that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 15
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Surface Soil	AOC-4	Ingestion	**Inorganics**												
				ALUMINUM	1.38E+04	(mg/kg)	6.46E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	1.88E-02	(mg/kg-day)	1.00E+00	(mg/kg-day)	1.9E-02
				ARSENIC	3.85E+00	(mg/kg)	1.81E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	2.7E-06	5.27E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.8E-02
				COBALT	2.50E+00	(mg/kg)	1.17E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	3.42E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.1E-02
				IRON	8.05E+03	(mg/kg)	3.78E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	1.10E-02	(mg/kg-day)	7.00E-01	(mg/kg-day)	1.6E-02
				MANGANESE	1.79E+02	(mg/kg)	8.41E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	2.45E-04	(mg/kg-day)	4.70E-02	(mg/kg-day)	5.2E-03
				MERCURY	1.04E+00	(mg/kg)	4.88E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.42E-06	(mg/kg-day)	1.00E-04	(mg/kg-day)	1.4E-02
				SELENIUM	4.28E+02	(mg/kg)	2.01E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	5.86E-04	(mg/kg-day)	5.00E-03	(mg/kg-day)	1.2E-01
				PAHs												
				BENZ(A)ANTHRACENE	4.90E-01	(mg/kg)	4.14E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	3.0E-07	6.71E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	7.25E-01	(mg/kg)	6.13E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.5E-07	9.93E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.38E-01	(mg/kg)	3.70E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.7E-06	6.00E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	6.98E-02	(mg/kg)	5.90E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	4.3E-07	9.56E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	2.69E-01	(mg/kg)	2.27E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.7E-07	3.68E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**6.8E-06**					**2.0E-01**
			Dermal[1]	**Inorganics**												
				ALUMINUM	1.38E+04	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E+00	(mg/kg-day)	--
				ARSENIC	3.85E+00	(mg/kg)	2.16E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	3.2E-07	6.31E-07	(mg/kg-day)	3.00E-04	(mg/kg-day)	2.1E-03
				COBALT	2.50E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
				IRON	8.05E+03	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	7.00E-01	(mg/kg-day)	--
				MANGANESE	1.79E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.88E-03	(mg/kg-day)	--
				MERCURY	1.04E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E-04	(mg/kg-day)	--
				SELENIUM	4.28E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	5.00E-03	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	4.90E-01	(mg/kg)	2.15E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.6E-07	3.48E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	7.25E-01	(mg/kg)	3.18E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.3E-07	5.15E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.38E-01	(mg/kg)	1.92E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.4E-06	3.11E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	6.98E-02	(mg/kg)	3.06E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.2E-07	4.96E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	2.69E-01	(mg/kg)	1.18E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	8.6E-08	1.91E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**2.4E-06**					**2.1E-03**
		Exposure Point Total									**9.2E-06**					**2.0E-01**
	Exposure Medium Total										**9.2E-06**					**2.0E-01**
	Air	AOC-4	Inhalation	**Inorganics**												
				ALUMINUM	4.93E-05	(mg/m^3)	1.62E-02	(ug/m^3)	NA	per (ug/m^3)	--	4.73E-05	(mg/m^3)	5.00E-03	(mg/m^3)	9.5E-03
				ARSENIC	1.38E-08	(mg/m^3)	4.53E-06	(ug/m^3)	4.30E-03	per (ug/m^3)	1.9E-08	1.32E-08	(mg/m^3)	1.50E-05	(mg/m^3)	8.8E-04
				COBALT	8.95E-09	(mg/m^3)	2.94E-06	(ug/m^3)	9.00E-03	per (ug/m^3)	2.6E-08	8.58E-09	(mg/m^3)	6.00E-06	(mg/m^3)	1.4E-03
				IRON	2.89E-05	(mg/m^3)	9.49E-03	(ug/m^3)	NA	per (ug/m^3)	--	2.77E-05	(mg/m^3)	NA	(mg/m^3)	--
				MANGANESE	6.42E-07	(mg/m^3)	2.11E-04	(ug/m^3)	NA	per (ug/m^3)	--	6.15E-07	(mg/m^3)	5.00E-05	(mg/m^3)	1.2E-02
				MERCURY	3.73E-09	(mg/m^3)	1.23E-06	(ug/m^3)	NA	per (ug/m^3)	--	3.57E-09	(mg/m^3)	3.00E-04	(mg/m^3)	1.2E-05
				SELENIUM	1.53E-06	(mg/m^3)	5.04E-04	(ug/m^3)	NA	per (ug/m^3)	--	1.47E-06	(mg/m^3)	2.00E-02	(mg/m^3)	7.4E-05
				PAHs												
				BENZ(A)ANTHRACENE	1.76E-09	(mg/m^3)	1.04E-06	(ug/m^3)	1.10E-04	per (ug/m^3)	1.1E-10	1.68E-09	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(B)FLUORANTHENE	2.60E-09	(mg/m^3)	1.54E-06	(ug/m^3)	1.10E-04	per (ug/m^3)	1.7E-10	2.49E-09	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(A)PYRENE	1.57E-09	(mg/m^3)	9.29E-07	(ug/m^3)	1.10E-03	per (ug/m^3)	1.0E-09	1.51E-09	(mg/m^3)	NA	(mg/m^3)	--
				DIBENZ(A,H)ANTHRACENE	2.50E-10	(mg/m^3)	1.48E-07	(ug/m^3)	1.10E-03	per (ug/m^3)	1.6E-10	2.40E-10	(mg/m^3)	NA	(mg/m^3)	--
				INDENO(1,2,3-C,D)PYRENE	9.64E-10	(mg/m^3)	5.71E-07	(ug/m^3)	1.10E-04	per (ug/m^3)	6.3E-11	9.25E-10	(mg/m^3)	NA	(mg/m^3)	--
			Exp. Route Total								**4.8E-08**					**2.4E-02**
		Exposure Point Total									**4.8E-08**					**2.4E-02**
	Exposure Medium Total										**4.8E-08**					**2.4E-02**
Soil Total											**9.2E-06**					**2.3E-01**
										Total of Receptor Risks Across All Media	**9.2E-06**				Total of Receptor Hazards Across All Media	**2.3E-01**

NOTES:
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table D.5.3 and U.S. EPA 2004 guidance.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 16
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Surface Soil	AOC-4	Ingestion	**Inorganics**												
				ALUMINUM	1.38E+04	(mg/kg)	1.51E-02	(mg/kg-day)	NA	per (mg/kg-day)	--	1.76E-01	(mg/kg-day)	1.00E+00	(mg/kg-day)	1.8E-01
				ARSENIC	3.85E+00	(mg/kg)	4.21E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	6.3E-06	4.92E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.6E-01
				COBALT	2.50E+00	(mg/kg)	2.74E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	3.19E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.1E-01
				IRON	8.05E+03	(mg/kg)	8.83E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	1.03E-01	(mg/kg-day)	7.00E-01	(mg/kg-day)	1.5E-01
				MANGANESE	1.79E+02	(mg/kg)	1.96E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	2.29E-03	(mg/kg-day)	4.70E-02	(mg/kg-day)	4.9E-02
				MERCURY	1.04E+00	(mg/kg)	1.14E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.33E-05	(mg/kg-day)	1.00E-04	(mg/kg-day)	1.3E-01
				SELENIUM	4.28E+02	(mg/kg)	4.69E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	5.47E-03	(mg/kg-day)	5.00E-03	(mg/kg-day)	1.1E+00
				PAHs												
				BENZ(A)ANTHRACENE	4.90E-01	(mg/kg)	2.85E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.1E-06	6.26E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	7.25E-01	(mg/kg)	4.21E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	3.1E-06	9.27E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.38E-01	(mg/kg)	2.54E-06	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.9E-05	5.60E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	6.98E-02	(mg/kg)	4.05E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	3.0E-06	8.92E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	2.69E-01	(mg/kg)	1.56E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.1E-06	3.44E-06	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**3.4E-05**					**1.9E+00**
			Dermal[1]	**Inorganics**												
				ALUMINUM	1.38E+04	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E+00	(mg/kg-day)	--
				ARSENIC	3.85E+00	(mg/kg)	3.54E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	5.3E-07	4.13E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.4E-02
				COBALT	2.50E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
				IRON	8.05E+03	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	7.00E-01	(mg/kg-day)	--
				MANGANESE	1.79E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.88E-03	(mg/kg-day)	--
				MERCURY	1.04E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E-04	(mg/kg-day)	--
				SELENIUM	4.28E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	5.00E-03	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	4.90E-01	(mg/kg)	1.04E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	7.6E-07	2.28E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	7.25E-01	(mg/kg)	1.53E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.1E-06	3.37E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.38E-01	(mg/kg)	9.26E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	6.8E-06	2.04E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	6.98E-02	(mg/kg)	1.48E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.1E-06	3.25E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	2.69E-01	(mg/kg)	5.69E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.2E-07	1.25E-06	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**1.1E-05**					**1.4E-02**
		Exposure Point Total									**4.5E-05**					**1.9E+00**
	Exposure Medium Total										**4.5E-05**					**1.9E+00**
	Air	AOC-4	Inhalation	**Inorganics**												
				ALUMINUM	4.93E-05	(mg/m^3)	4.05E-03	(ug/m^3)	NA	per (ug/m^3)	--	4.73E-05	(mg/m^3)	5.00E-03	(mg/m^3)	9.5E-03
				ARSENIC	1.38E-08	(mg/m^3)	1.13E-06	(ug/m^3)	4.30E-03	per (ug/m^3)	4.9E-09	1.32E-08	(mg/m^3)	1.50E-05	(mg/m^3)	8.8E-04
				COBALT	8.95E-09	(mg/m^3)	7.36E-07	(ug/m^3)	9.00E-03	per (ug/m^3)	6.6E-09	8.58E-09	(mg/m^3)	6.00E-06	(mg/m^3)	1.4E-03
				IRON	2.89E-05	(mg/m^3)	2.37E-03	(ug/m^3)	NA	per (ug/m^3)	--	2.77E-05	(mg/m^3)	NA	(mg/m^3)	--
				MANGANESE	6.42E-07	(mg/m^3)	5.27E-05	(ug/m^3)	NA	per (ug/m^3)	--	6.15E-07	(mg/m^3)	5.00E-05	(mg/m^3)	1.2E-02
				MERCURY	3.73E-09	(mg/m^3)	3.06E-07	(ug/m^3)	NA	per (ug/m^3)	--	3.57E-09	(mg/m^3)	3.00E-04	(mg/m^3)	1.2E-05
				SELENIUM	1.53E-06	(mg/m^3)	1.26E-04	(ug/m^3)	NA	per (ug/m^3)	--	1.47E-06	(mg/m^3)	2.00E-02	(mg/m^3)	7.4E-05
				PAHs												
				BENZ(A)ANTHRACENE	1.76E-09	(mg/m^3)	7.65E-07	(ug/m^3)	1.10E-04	per (ug/m^3)	8.4E-11	1.68E-09	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(B)FLUORANTHENE	2.60E-09	(mg/m^3)	1.13E-06	(ug/m^3)	1.10E-04	per (ug/m^3)	1.2E-10	2.49E-09	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(A)PYRENE	1.57E-09	(mg/m^3)	6.84E-07	(ug/m^3)	1.10E-03	per (ug/m^3)	7.5E-10	1.51E-09	(mg/m^3)	NA	(mg/m^3)	--
				DIBENZ(A,H)ANTHRACENE	2.50E-10	(mg/m^3)	1.09E-07	(ug/m^3)	1.10E-03	per (ug/m^3)	1.2E-10	2.40E-10	(mg/m^3)	NA	(mg/m^3)	--
				INDENO(1,2,3-C,D)PYRENE	9.64E-10	(mg/m^3)	4.20E-07	(ug/m^3)	1.10E-04	per (ug/m^3)	4.6E-11	9.25E-10	(mg/m^3)	NA	(mg/m^3)	--
			Exp. Route Total								**1.3E-08**					**2.4E-02**
		Exposure Point Total									**1.3E-08**					**2.4E-02**
	Exposure Medium Total										**1.3E-08**					**2.4E-02**
Soil Total											**4.5E-05**					**1.9E+00**
										Total of Receptor Risks Across All Media	**4.5E-05**				Total of Receptor Hazards Across All Media	**1.9E+00**

TABLE 16
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	

NOTES:
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table D.5.3 and U.S. EPA 2004 guidance.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 17
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Surface Soil	AOC-4	Ingestion	**Inorganics**												
				ALUMINUM	1.38E+04	(mg/kg)	6.35E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	4.44E-02	(mg/kg-day)	1.0E+00	(mg/kg-day)	4.4E-02
				ARSENIC	3.85E+00	(mg/kg)	1.77E-07	(mg/kg-day)	1.5E+00	per (mg/kg-day)	2.7E-07	1.24E-05	(mg/kg-day)	3.0E-04	(mg/kg-day)	4.1E-02
				COBALT	2.50E+00	(mg/kg)	1.15E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	8.06E-06	(mg/kg-day)	3.0E-04	(mg/kg-day)	2.7E-02
				MANGANESE	1.79E+02	(mg/kg)	8.26E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	5.78E-04	(mg/kg-day)	4.7E-02	(mg/kg-day)	1.2E-02
				MERCURY	1.04E+00	(mg/kg)	4.80E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	3.36E-06	(mg/kg-day)	1.00E-04	(mg/kg-day)	3.36E-02
				SELENIUM	4.28E+02	(mg/kg)	1.97E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	1.38E-03	(mg/kg-day)	5.00E-03	(mg/kg-day)	2.76E-01
				PAHs												
				BENZ(A)ANTHRACENE	4.90E-01	(mg/kg)	2.26E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	1.7E-08	1.58E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	7.25E-01	(mg/kg)	3.34E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	2.4E-08	2.34E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.38E-01	(mg/kg)	2.02E-08	(mg/kg-day)	7.3E+00	per (mg/kg-day)	1.5E-07	1.41E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	6.98E-02	(mg/kg)	3.22E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	2.4E-08	2.25E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	2.69E-01	(mg/kg)	1.24E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	9.1E-09	8.69E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**4.9E-07**					**4.7E-01**
			Dermal[1]	**Inorganics**												
				ALUMINUM	1.38E+04	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1E+00	(mg/kg-day)	--
				ARSENIC	3.85E+00	(mg/kg)	1.06E-08	(mg/kg-day)	1.5E+00	per (mg/kg-day)	1.6E-08	7.45E-07	(mg/kg-day)	3E-04	(mg/kg-day)	2.5E-03
				COBALT	2.50E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3E-04	(mg/kg-day)	--
				MANGANESE	1.79E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	2E-03	(mg/kg-day)	--
				MERCURY	1.04E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1E-04	(mg/kg-day)	--
				SELENIUM	4.28E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	5E-03	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	4.90E-01	(mg/kg)	5.88E-09	(mg/kg-day)	7.3E-01	per (mg/kg-day)	4.3E-09	4.11E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	7.25E-01	(mg/kg)	8.70E-09	(mg/kg-day)	7.3E-01	per (mg/kg-day)	6.3E-09	6.09E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.38E-01	(mg/kg)	5.25E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	3.8E-08	3.68E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	6.98E-02	(mg/kg)	8.37E-10	(mg/kg-day)	7.3E+00	per (mg/kg-day)	6.1E-09	5.86E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	2.69E-01	(mg/kg)	3.23E-09	(mg/kg-day)	7.3E-01	per (mg/kg-day)	2.4E-09	2.26E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**7.3E-08**					**2.5E-03**
		Exposure Point Total									**5.6E-07**					**4.7E-01**
	Exposure Medium Total										**5.6E-07**					**4.7E-01**
	Air	AOC-4	Inhalation	**Inorganics**												
				ALUMINUM	7.36E-04	(mg/m^3)	2.40E-03	(ug/m^3)	NA	per (ug/m^3)	--	1.68E-04	(mg/m^3)	5E-03	(mg/m^3)	3.4E-02
				ARSENIC	2.06E-07	(mg/m^3)	6.71E-07	(ug/m^3)	4.3E-03	per (ug/m^3)	2.9E-09	4.70E-08	(mg/m^3)	2E-05	(mg/m^3)	3.1E-03
				COBALT	1.34E-07	(mg/m^3)	4.36E-07	(ug/m^3)	9.0E-03	per (ug/m^3)	3.9E-09	3.05E-08	(mg/m^3)	6E-06	(mg/m^3)	5.1E-03
				MANGANESE	9.57E-06	(mg/m^3)	3.12E-05	(ug/m^3)	NA	per (ug/m^3)	--	2.19E-06	(mg/m^3)	5E-05	(mg/m^3)	4.4E-02
				MERCURY	5.56E-08	(mg/m^3)	1.81E-07	(ug/m^3)	NA	per (ug/m^3)	--	1.27E-08	(mg/m^3)	3E-04	(mg/m^3)	4.2E-05
				SELENIUM	2.29E-05	(mg/m^3)	7.47E-05	(ug/m^3)	NA	per (ug/m^3)	--	5.23E-06	(mg/m^3)	2E-02	(mg/m^3)	2.6E-04
				PAHs												
				BENZ(A)ANTHRACENE	2.62E-08	(mg/m^3)	8.55E-08	(ug/m^3)	1.1E-04	per (ug/m^3)	9.4E-12	5.98E-09	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(B)FLUORANTHENE	3.88E-08	(mg/m^3)	1.26E-07	(ug/m^3)	1.1E-04	per (ug/m^3)	1.4E-11	8.85E-09	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(A)PYRENE	2.34E-08	(mg/m^3)	7.64E-08	(ug/m^3)	1.1E-03	per (ug/m^3)	8.4E-11	5.35E-09	(mg/m^3)	NA	(mg/m^3)	--
				DIBENZ(A,H)ANTHRACENE	3.73E-09	(mg/m^3)	1.22E-08	(ug/m^3)	1.1E-03	per (ug/m^3)	1.3E-11	8.52E-10	(mg/m^3)	NA	(mg/m^3)	--
				INDENO(1,2,3-C,D)PYRENE	1.44E-08	(mg/m^3)	4.69E-08	(ug/m^3)	1.1E-04	per (ug/m^3)	5.2E-12	3.28E-09	(mg/m^3)	NA	(mg/m^3)	--
			Exp. Route Total								**6.9E-09**					**8.6E-02**
		Exposure Point Total									**6.9E-09**					**8.6E-02**
	Exposure Medium Total										**6.9E-09**					**8.6E-02**
Soil Total											**5.7E-07**					**5.6E-01**
									Total of Receptor Risks Across All Media		**5.7E-07**		Total of Receptor Hazards Across All Media			**5.6E-01**

TABLE 17
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

NOTES:
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 5.1.3 and U.S. EPA 2004 guidance.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 18
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Subsurface Soil	AOC-4	Ingestion	**Inorganics**												
				ARSENIC	1.27E+00	(mg/kg)	5.96E-07	(mg/kg-day)	1.5E+00	per (mg/kg-day)	8.9E-07	1.74E-06	(mg/kg-day)	3.0E-04	(mg/kg-day)	5.8E-03
				MERCURY	2.12E+00	(mg/kg)	9.94E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.90E-06	(mg/kg-day)	1.0E-04	(mg/kg-day)	2.9E-02
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	1.32E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	9.6E-08	2.14E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	1.83E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	1.3E-07	2.96E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	1.29E-07	(mg/kg-day)	7.3E+00	per (mg/kg-day)	9.4E-07	2.10E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	9.98E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	7.3E-08	1.62E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	1.03E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	7.5E-08	1.67E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**2.2E-06**					**3.5E-02**
			Dermal[1]	**Inorganics**												
				ARSENIC	1.27E+00	(mg/kg)	7.14E-08	(mg/kg-day)	1.5E+00	per (mg/kg-day)	1.1E-07	2.08E-07	(mg/kg-day)	3.0E-04	(mg/kg-day)	6.9E-04
				MERCURY	2.12E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.0E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	6.84E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	5.0E-08	1.11E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	9.47E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	6.9E-08	1.53E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	6.71E-08	(mg/kg-day)	7.3E+00	per (mg/kg-day)	4.9E-07	1.09E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	5.17E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	3.8E-08	8.38E-09	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	5.35E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	3.9E-08	8.67E-08	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**7.9E-07**					**6.9E-04**
		Exposure Point Total									**3.0E-06**					**3.5E-02**
	Exposure Medium Total										**3.0E-06**					**3.5E-02**
	Air	AOC-4	Inhalation	**Inorganics**												
				ARSENIC	4.55E-09	(mg/m^3)	1.50E-06	(ug/m^3)	4.3E-03	per (ug/m^3)	6.4E-09	4.36E-09	(mg/m^3)	1.5E-05	(mg/m^3)	2.9E-04
				MERCURY	7.58E-09	(mg/m^3)	2.49E-06	(ug/m^3)	NA	per (ug/m^3)	--	7.27E-09	(mg/m^3)	3.0E-04	(mg/m^3)	2.4E-05
				PAHs												
				BENZ(A)ANTHRACENE	5.59E-10	(mg/m^3)	3.31E-07	(ug/m^3)	1.1E-04	per (ug/m^3)	3.6E-11	5.36E-10	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(B)FLUORANTHENE	7.74E-10	(mg/m^3)	4.58E-07	(ug/m^3)	1.1E-04	per (ug/m^3)	5.0E-11	7.42E-10	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(A)PYRENE	5.48E-10	(mg/m^3)	3.25E-07	(ug/m^3)	1.1E-03	per (ug/m^3)	3.6E-10	5.26E-10	(mg/m^3)	NA	(mg/m^3)	--
				DIBENZ(A,H)ANTHRACENE	4.23E-11	(mg/m^3)	2.50E-08	(ug/m^3)	1.1E-03	per (ug/m^3)	2.8E-11	4.06E-11	(mg/m^3)	NA	(mg/m^3)	--
				INDENO(1,2,3-C,D)PYRENE	4.37E-10	(mg/m^3)	2.59E-07	(ug/m^3)	1.1E-04	per (ug/m^3)	2.8E-11	4.19E-10	(mg/m3)	NA	(mg/m^3)	--
			Exp. Route Total								**6.9E-09**					**3.2E-04**
		Exposure Point Total									**6.9E-09**					**3.2E-04**
	Exposure Medium Total										**6.9E-09**					**3.2E-04**
Soil Total											**3.0E-06**					**3.6E-02**
										Total of Receptor Risks Across All Media	**3.0E-06**				Total of Receptor Hazards Across All Media	**3.6E-02**

NOTES:
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 5.1.3 and U.S. EPA 2004 guidance.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 19
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Subsurface Soil	AOC-4	Ingestion	**Inorganics**												
				ARSENIC	1.27E+00	(mg/kg)	1.39E-06	(mg/kg-day)	1.5E+00	per (mg/kg-day)	2.1E-06	1.62E-05	(mg/kg-day)	3E-04	(mg/kg-day)	5.4E-02
				MERCURY	2.12E+00	(mg/kg)	2.32E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	2.71E-05	(mg/kg-day)	1E-04	(mg/kg-day)	2.7E-01
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	9.06E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	6.6E-07	1.99E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	1.25E-06	(mg/kg-day)	7.3E-01	per (mg/kg-day)	9.2E-07	2.76E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	8.89E-07	(mg/kg-day)	7.3E+00	per (mg/kg-day)	6.5E-06	1.96E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	6.85E-08	(mg/kg-day)	7.3E+00	per (mg/kg-day)	5.0E-07	1.51E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	7.09E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	5.2E-07	1.56E-06	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**1.1E-05**					**3.2E-01**
			Dermal[1]	**Inorganics**												
				ARSENIC	1.27E+00	(mg/kg)	1.17E-07	(mg/kg-day)	1.5E+00	per (mg/kg-day)	1.8E-07	1.36E-06	(mg/kg-day)	3.0E-04	(mg/kg-day)	4.5E-03
				MERCURY	2.12E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.0E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	3.30E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	2.4E-07	7.26E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	4.57E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	3.3E-07	1.01E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	3.23E-07	(mg/kg-day)	7.3E+00	per (mg/kg-day)	2.4E-06	7.12E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	2.49E-08	(mg/kg-day)	7.3E+00	per (mg/kg-day)	1.8E-07	5.49E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	2.58E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	1.9E-07	5.68E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**3.5E-06**					**4.5E-03**
		Exposure Point Total									**1.5E-05**					**3.3E-01**
	Exposure Medium Total										**1.5E-05**					**3.3E-01**
	Air	AOC-4	Inhalation	**Inorganics**												
				ARSENIC	4.55E-09	(mg/m^3)	3.74E-07	(ug/m^3)	4.3E-03	per (ug/m^3)	1.6E-09	4.36E-09	(mg/m^3)	1.5E-05	(mg/m^3)	2.9E-04
				MERCURY	7.58E-09	(mg/m^3)	6.23E-07	(ug/m^3)	NA	per (ug/m^3)	--	7.27E-09	(mg/m^3)	3.0E-04	(mg/m^3)	2.4E-05
				PAHs												
				BENZ(A)ANTHRACENE	5.59E-10	(mg/m^3)	2.44E-07	(ug/m^3)	1.1E-04	per (ug/m^3)	2.7E-11	5.36E-10	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(B)FLUORANTHENE	7.74E-10	(mg/m^3)	3.37E-07	(ug/m^3)	1.1E-04	per (ug/m^3)	3.7E-11	7.42E-10	(mg/m^3)	NA	(mg/m^3)	--
				BENZO(A)PYRENE	5.48E-10	(mg/m^3)	2.39E-07	(ug/m^3)	1.1E-03	per (ug/m^3)	2.6E-10	5.26E-10	(mg/m^3)	NA	(mg/m^3)	--
				DIBENZ(A,H)ANTHRACENE	4.23E-11	(mg/m^3)	1.84E-08	(ug/m^3)	1.1E-03	per (ug/m^3)	2.0E-11	4.06E-11	(mg/m^3)	NA	(mg/m^3)	--
				INDENO(1,2,3-C,D)PYRENE	4.37E-10	(mg/m^3)	1.90E-07	(ug/m^3)	1.1E-04	per (ug/m^3)	2.1E-11	4.19E-10	(mg/m^3)	NA	(mg/m^3)	--
			Exp. Route Total								**2.0E-09**					**3.2E-04**
		Exposure Point Total									**2.0E-09**					**3.2E-04**
	Exposure Medium Total										**2.0E-09**					**3.2E-04**
Soil Total											**1.5E-05**					**3.3E-01**
										Total of Receptor Risks Across All Media	**1.5E-05**				Total of Receptor Hazards Across All Media	**3.3E-01**

NOTES:
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 5.1.3 and U.S. EPA 2004 guidance.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 20
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Subsurface Soil	AOC-4	Ingestion	**Inorganics**												
				ARSENIC	1.27E+00	(mg/kg)	5.86E-08	(mg/kg-day)	1.50E+00	per (mg/kg-day)	8.8E-08	4.10E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.4E-02
				MERCURY	2.12E+00	(mg/kg)	9.76E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	6.83E-06	(mg/kg-day)	1.00E-04	(mg/kg-day)	6.8E-02
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	7.20E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	5.3E-09	5.04E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	9.96E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	7.3E-09	6.97E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	7.06E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	5.2E-08	4.94E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	5.44E-10	(mg/kg-day)	7.30E+00	per (mg/kg-day)	4.0E-09	3.81E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	5.63E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.1E-09	3.94E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**1.6E-07**					**8.2E-02**
			Dermal[1]	**Inorganics**												
				ARSENIC	1.27E+00	(mg/kg)	3.51E-09	(mg/kg-day)	1.50E+00	per (mg/kg-day)	5.3E-09	2.46E-07	(mg/kg-day)	3.00E-04	(mg/kg-day)	8.2E-04
				MERCURY	2.12E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	1.87E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.4E-09	1.31E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	2.59E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.9E-09	1.81E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	1.83E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	1.3E-08	1.28E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	1.42E-10	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.0E-09	9.91E-09	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	1.46E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.1E-09	1.02E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**2.4E-08**					**8.2E-04**
		Exposure Point Total									**1.8E-07**					**8.3E-02**
	Exposure Medium Total										**1.8E-07**					**8.3E-02**
	Air	AOC-4	Inhalation	**Inorganics**												
				ARSENIC	6.79E-08	(mg/m^3)	2.22E-07	(ug/m^3)	4.30E-03	per (ug/m^3)	9.5E-10	1.55E-08	(µg/m^3)	1.50E-05	(mg/m^3)	1.0E-03
				MERCURY	1.13E-07	(mg/m^3)	3.69E-07	(ug/m^3)	NA	per (ug/m^3)	--	2.58E-08	(mg/m^3)	3.00E-04	(mg/m^3)	8.6E-05
				PAHs												
				BENZ(A)ANTHRACENE	8.34E-09	(mg/m^3)	2.72E-08	(ug/m3)	1.10E-04	per (ug/m3)	3.0E-12	1.90E-09	(mg/m3)	NA	(mg/m3)	--
				BENZO(B)FLUORANTHENE	1.16E-08	(mg/m^3)	3.77E-08	(ug/m3)	1.10E-04	per (ug/m3)	4.1E-12	2.64E-09	(mg/m3)	NA	(mg/m3)	--
				BENZO(A)PYRENE	8.18E-09	(mg/m^3)	2.67E-08	(ug/m^3)	1.1E-03	(ug/m^3)	2.9E-11	1.87E-09	(mg/m3)	NA	(mg/m3)	--
				DIBENZ(A,H)ANTHRACENE	6.31E-10	(mg/m^3)	2.06E-09	(ug/m3)	1.10E-03	per (ug/m3)	2.3E-12	1.44E-10	(mg/m3)	NA	(mg/m3)	--
				INDENO(1,2,3-C,D)PYRENE	6.52E-09	(mg/m^3)	2.13E-08	(ug/m3)	1.10E-04	per (ug/m3)	2.3E-12	1.49E-09	(mg/m3)	NA	(mg/m3)	--
			Exp. Route Total								**9.9E-10**					**1.1E-03**
		Exposure Point Total									**9.9E-10**					**1.1E-03**
	Exposure Medium Total										**9.9E-10**					**1.1E-03**
Soil Total											**1.9E-07**					**8.4E-02**
										Total of Receptor Risks Across All Media	**1.9E-07**				Total of Receptor Hazards Across All Media	**8.4E-02**

NOTES:
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 5.1.3 and U.S. EPA 2004 guidance.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 21

CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SOIL

RESIDENTIAL EXPOSURES

AOC-4, FALCON REFINERY SUPERFUND SITE

INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Model Equations:

Particulate Emmision Factor	PEF = Q/C x [(3,600 s/h)/(.36 x (1- V) x (Um/Ut)^3 x F(x))] =	**2.79E+08**
Air Concentration	Cair = Csoil/PEF	

Where,

Q/C =	7.92E+01	g/m^2-s per kg/m^3	Inverse Mean Concentration at Center of 0.05 square source for Houston, TX, USEPA 1996
V =	5.00E-01	unitless	Default, USEPA 2013a
Um =	3.49E+00	m/s	Mean annual wind speed, Houston, TX, USEPA 1996
Ut =	1.13E+01	m/s	Equivalent threshold value of windspeed at 7 m, USEPA 2013a
F(x) =	1.94E-01	unitless	Default, USEPA 2013a

Reference for the model: USEPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA, 1996.

Chemical	**Csoil, Surface Soil**	**Csoil, Subsurface Soil**	**Cair, Surface Soil Particulate**	**Cair, Subsurface Soil Particulate**
	RME EPC	RME EPC	RME EPC	RME EPC
	mg/kg	mg/kg	mg/m^3	mg/m^3
Inorganics				
ALUMINUM	1.38E+04	NA	4.93E-05	NA
ARSENIC	3.85E+00	1.27E+00	1.38E-08	4.55E-09
COBALT	2.50E+00	NA	8.95E-09	NA
IRON	8.05E+03	NA	2.89E-05	NA
MANGANESE	1.79E+02	NA	6.42E-07	NA
MERCURY	1.04E+00	2.12E+00	3.73E-09	7.58E-09
SELENIUM	4.28E+02	NA	1.53E-06	NA
PAHs				
BENZ(A)ANTHRACENE	4.90E-01	1.56E-01	1.76E-09	5.59E-10
BENZO(B)FLUORANTHENE	7.25E-01	2.16E-01	2.60E-09	7.74E-10
BENZO(A)PYRENE	4.38E-01	1.53E-01	1.57E-09	5.48E-10
DIBENZ(A,H)ANTHRACENE	6.98E-02	1.18E-02	2.50E-10	4.23E-11
INDENO(1,2,3-C,D)PYRENE	2.69E-01	1.22E-01	9.64E-10	4.37E-10

TABLE 22

CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SOIL

CONSTRUCTION WORKER - OTHER THAN STANDARD VEHICLE TRAFFIC

AOC-4, FALCON REFINERY SUPERFUND SITE

INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Model Equations:

Particulate Emmision Factor	**1.87E+07**		Calculated using EPA RSL Calculator (Calculations provided in Attachment 3)
Air Concentration			Cair = Csoil/PEF
Where,			
Area to be excavated, graded, tilled =	1.70E+00	acres	Entire area of AOC 4
Depth of excavation =	1.50E+00	meters	
Q/C =	1.43E+01	g/m^2-s per kg/m^3	calculated
Um =	4.69E+00	m/s	Mean annual wind speed, USEPA 2013a
Ut =	1.13E+01	m/s	Equivalent threshold value of windspeed at 7 m, USEPA 2013a
F(x) =	1.94E-01	unitless	Default, USEPA 2013a

Reference for the model: USEPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA, 1996.

Chemical	**Csoil, Surface Soil**	**Csoil, Subsurface Soil**	**Cair, Surface Soil Particulate**	**Cair, Subsurface Soil Particulate**
	RME EPC	RME EPC	RME EPC	RME EPC
	mg/kg	mg/kg	mg/m^3	mg/m^3
Inorganics				
ALUMINUM	1.38E+04	NA	7.36E-04	NA
ARSENIC	3.85E+00	1.27E+00	2.06E-07	6.79E-08
COBALT	2.50E+00	NA	1.34E-07	NA
IRON	8.05E+03	NA	4.31E-04	NA
MANGANESE	1.79E+02	NA	9.57E-06	NA
MERCURY	1.04E+00	2.12E+00	5.56E-08	1.13E-07
SELENIUM	4.28E+02	NA	2.29E-05	NA
PAHs				
BENZ(A)ANTHRACENE	4.90E-01	1.56E-01	2.62E-08	8.34E-09
BENZO(B)FLUORANTHENE	7.25E-01	2.16E-01	3.88E-08	1.16E-08
BENZO(A)PYRENE	4.38E-01	1.53E-01	2.34E-08	8.18E-09
DIBENZ(A,H)ANTHRACENE	6.98E-02	1.18E-02	3.73E-09	6.31E-10
INDENO(1,2,3-C,D)PYRENE	2.69E-01	1.22E-01	1.44E-08	6.52E-09

TABLE 23
SUMMARY OF RESIDENT CHILD IEUBK LEAD MODELING
AOC-4, FALCON REFINERY SUPERFUND SITE
INGELSIDE, SAN PATRICIO COUNTY, TEXAS

IEUBK MODEL SUMMARY					
Medium	Mean Concentration	Units	Mean (ug/dL)	% Below(1)	% Above(1)
Surface Soil	83.6	mg/kg	1.65	99.994	0.006

NOTE:
(1) Compared to the blood-level threshold of 10 ug/dL. Exceeds threshold if % Above is greater than 5.

TABLE 24
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC 4
Scenario Timeframe: Future Receptor Population: Resident Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil	AOC 4	**Inorganics**					**Inorganics**					
		(Child)	ALUMINUM	--	--	--	NA	ALUMINUM	Central Nervous System	1.8E-01	--	9.5E-03	1.9E-01
			ARSENIC	6.3E-06	5.3E-07	4.9E-09	6.9E-06	ARSENIC	Skin	1.6E-01	1.4E-02	8.8E-04	1.8E-01
			COBALT	--	--	6.6E-09	6.6E-09	COBALT	Thyroid	1.1E-01	--	1.4E-03	1.1E-01
			IRON	--	--	--	NA	IRON	Gastrointestinal System	1.5E-01	--	--	1.5E-01
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	4.9E-02	--	1.2E-02	6.1E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	1.3E-01	--	1.2E-05	1.3E-01
			SELENIUM	--	--	--	NA	SELENIUM	Hair and Skin	1.1E+00	--	7.4E-05	1.1E+00
			PAHs					**PAHs**					
			BENZ(A)ANTHRACENE	2.1E-06	7.6E-07	8.4E-11	2.8E-06	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	3.1E-06	1.1E-06	1.2E-10	4.2E-06	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	1.9E-05	6.8E-06	7.5E-10	2.5E-05	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	3.0E-06	1.1E-06	1.2E-10	4.0E-06	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	1.1E-06	4.2E-07	4.6E-11	1.6E-06	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total for Child)	3.4E-05	1.1E-05	1.3E-08	4.5E-05		(Total for Child)	1.9E+00	1.4E-02	2.4E-02	1.9E+00
	Surface Soil	AOC 4	**Inorganics**					**Inorganics**					
		(Adult)	ALUMINUM	--	--	--	NA	ALUMINUM	Central Nervous System	1.9E-02	--	9.5E-03	2.8E-02
			ARSENIC	2.7E-06	3.2E-07	1.9E-08	3.1E-06	ARSENIC	Skin	1.8E-02	2.1E-03	8.8E-04	2.1E-02
			COBALT	--	--	2.6E-08	2.6E-08	COBALT	Thyroid	1.1E-02	--	1.4E-03	1.3E-02
			IRON	--	--	--	NA	IRON	Gastrointestinal System	1.6E-02	--	--	1.6E-02
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	5.2E-03	--	1.2E-02	1.8E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	1.4E-02	--	1.2E-05	1.4E-02
			SELENIUM	--	--	--	NA	SELENIUM	Hair and Skin	1.2E-01	--	7.4E-05	1.2E-01
			PAHs					**PAHs**					
			BENZ(A)ANTHRACENE	3.0E-07	1.6E-07	1.1E-10	4.6E-07	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	4.5E-07	2.3E-07	1.7E-10	6.8E-07	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	2.7E-06	1.4E-06	1.0E-09	4.1E-06	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	4.3E-07	2.2E-07	1.6E-10	6.5E-07	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	1.7E-07	8.6E-08	6.3E-11	2.5E-07	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total for Adult)	6.8E-06	2.4E-06	4.8E-08	9.2E-06		(Total for Adult)	2.0E-01	2.1E-03	2.4E-02	2.3E-01
	Surface Soil	AOC 4	**Inorganics**										
		(Adult + Child)	ARSENIC	9.0E-06	8.6E-07	2.4E-08	9.9E-06						
			COBALT	NA	NA	3.3E-08	3.3E-08						
			PAHs										
			BENZ(A)ANTHRACENE	2.4E-06	9.1E-07	2.0E-10	3.3E-06						
			BENZO(B)FLUORANTHENE	3.5E-06	1.4E-06	2.9E-10	4.9E-06						
			BENZO(A)PYRENE	2.1E-05	8.2E-06	1.8E-09	2.9E-05						
			DIBENZ(A,H)ANTHRACENE	3.4E-06	1.3E-06	2.8E-10	4.7E-06						
			INDENO(1,2,3-C,D)PYRENE	1.3E-06	5.0E-07	1.1E-10	1.8E-06						
			(Total for Child + Adult)	4.1E-05	1.3E-05	6.0E-08	5.4E-05	**Total Hazard Index Across Surface Soil (Child)**					**1.9E+00**
				Total Risk Across Surface Soil			**5.4E-05**	**Total Hazard Index Across Surface Soil (Adult)**					**2.3E-01**

TABLE 24
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC 4
Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
						Total Risk Across All Media and All Exposure Routes	**5E-05**					Total Hazard Index Across All Media and All Exposure Routes (Child)	**2**
												Total Hazard Index Across All Media and All Exposure Routes (Adult)	**0.2**

Total Hazard Index Central Nervous System (Child)	**0.4**
Total Hazard Index Skin (Child)	**1**
Total Hazard Index Thyroid (Child)	**0.1**
Total Hazard Index Hair (Child)	**1**

TABLE 25
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC 4
Scenario Timeframe: Current/Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil	AOC 4	**Inorganics**					**Inorganics**					
			ALUMINUM	--	--	--	NA	ALUMINUM	Central Nervous System	4.4E-02	--	3.4E-02	7.8E-02
			ARSENIC	2.7E-07	1.6E-08	2.9E-09	2.8E-07	ARSENIC	Skin	4.1E-02	2.5E-03	3.1E-03	4.7E-02
			COBALT	--	--	3.9E-09	3.9E-09	COBALT	Thyroid	2.7E-02	--	5.1E-03	3.2E-02
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	1.2E-02	--	4.4E-02	5.6E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	3.4E-02	--	4.2E-05	3.4E-02
			SELENIUM	--	--	--	NA	SELENIUM	Hair and Skin	2.8E-01	--	2.6E-04	2.8E-01
			PAHs					**PAHs**					
			BENZ(A)ANTHRACENE	1.7E-08	4.3E-09	9.4E-12	2.1E-08	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	2.4E-08	6.3E-09	1.4E-11	3.1E-08	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	1.5E-07	3.8E-08	8.4E-11	1.9E-07	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	2.4E-08	6.1E-09	1.3E-11	3.0E-08	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	9.1E-09	2.4E-09	5.2E-12	1.1E-08	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total)	4.9E-07	7.3E-08	6.9E-09	5.7E-07		(Total)	4.7E-01	2.5E-03	8.6E-02	5.6E-01
						Total Risk Across Surface Soil	**5.7E-07**					**Total Hazard Index Across Surface Soil**	**5.6E-01**
						Total Risk Across All Media and All Exposure Routes	**6E-07**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.6**

NOTES:
NA = Not applicable due to no toxicity values.
-- = No risks calculated for this exposure pathway.

TABLE 26
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC 4
Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	AOC 4 (Child)	**Inorganics**					**Inorganics**					
			ARSENIC	2.1E-06	1.8E-07	1.6E-09	2.3E-06	ARSENIC	Skin	5.4E-02	4.5E-03	2.9E-04	5.9E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	2.7E-01	--	2.4E-05	2.7E-01
			PAHs					**PAHs**					
			BENZ(A)ANTHRACENE	6.6E-07	2.4E-07	2.7E-11	9.0E-07	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	9.2E-07	3.3E-07	3.7E-11	1.2E-06	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	6.5E-06	2.4E-06	2.6E-10	8.8E-06	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	5.0E-07	1.8E-07	2.0E-11	6.8E-07	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	5.2E-07	1.9E-07	2.1E-11	7.1E-07	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total for Child)	1.1E-05	3.5E-06	2.0E-09	1.5E-05		(Total for Child)	3.2E-01	4.5E-03	3.2E-04	3.3E-01
	Subsurface Soil	AOC 4 (Adult)	**Inorganics**					**Inorganics**					
			ARSENIC	8.9E-07	1.1E-07	6.4E-09	1.0E-06	ARSENIC	Skin	5.8E-03	6.9E-04	2.9E-04	6.8E-03
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	2.9E-02	--	2.4E-05	2.9E-02
			PAHs					**PAHs**					
			BENZ(A)ANTHRACENE	9.6E-08	5.0E-08	3.6E-11	1.5E-07	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	1.3E-07	6.9E-08	5.0E-11	2.0E-07	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	9.4E-07	4.9E-07	3.6E-10	1.4E-06	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	7.3E-08	3.8E-08	2.8E-11	1.1E-07	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	7.5E-08	3.9E-08	2.8E-11	1.1E-07	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total for Adult)	2.2E-06	7.9E-07	6.9E-09	3.0E-06		(Total for Adult)	3.5E-02	6.9E-04	3.2E-04	3.6E-02
	Subsurface Soil	AOC 4 (Adult + Child)	**Inorganics**										
			ARSENIC	3.0E-06	2.8E-07	8.0E-09	3.3E-06						
			PAHs										
			BENZ(A)ANTHRACENE	7.6E-07	2.9E-07	6.3E-11	1.0E-06						
			BENZO(B)FLUORANTHENE	1.0E-06	4.0E-07	8.7E-11	1.5E-06						
			BENZO(A)PYRENE	7.4E-06	2.9E-06	6.2E-10	1.0E-05						
			DIBENZ(A,H)ANTHRACENE	5.7E-07	2.2E-07	4.8E-11	7.9E-07						
			INDENO(1,2,3-C,D)PYRENE	5.9E-07	2.3E-07	4.9E-11	8.2E-07						
			(Total for Child + Adult)	1.3E-05	4.3E-06	8.9E-09	1.8E-05	**Total Hazard Index Across Subsurface Soil (Child)**					**3.3E-01**
			Total Risk Across Subsurface Soil				**1.8E-05**	**Total Hazard Index Across Subsurface Soil (Adult)**					**3.6E-02**
			Total Risk Across All Media and All Exposure Routes				**2E-05**	**Total Hazard Index Across All Media and All Exposure Routes (Child)**					**0.3**
								Total Hazard Index Across All Media and All Exposure Routes (Adult)					**0.04**

NA = Not applicable due to no toxicity values.
-- = No risks calculated for this exposure pathway.

TABLE 27
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
AOC-4, FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC 4	
Scenario Timeframe: Future Receptor Population: Construction Worker Receptor Age: Adult	

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	AOC 4	**Inorganics**					**Inorganics**					
			ARSENIC	8.8E-08	5.3E-09	9.5E-10	9.4E-08	ARSENIC	Skin	1.4E-02	8.2E-04	1.0E-03	1.6E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	6.8E-02	--	8.6E-05	6.8E-02
			PAHs					**PAHs**					
			BENZ(A)ANTHRACENE	5.3E-09	1.4E-09	3.0E-12	6.6E-09	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	7.3E-09	1.9E-09	4.1E-12	9.2E-09	BENZO(B)FLUORANTHEN	NA	--	--	--	NA
			BENZO(A)PYRENE	5.2E-08	1.3E-08	2.9E-11	6.5E-08	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	4.0E-09	1.0E-09	2.3E-12	5.0E-09	DIBENZ(A,H)ANTHRACEN	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	4.1E-09	1.1E-09	2.3E-12	5.2E-09	INDENO(1,2,3-C,D)PYREN	NA	--	--	--	NA
			(Total)	1.6E-07	2.4E-08	9.9E-10	1.9E-07		(Total)	8.2E-02	8.2E-04	1.1E-03	8.4E-02
Total Risk Across Subsurface Soil							**1.9E-07**	**Total Hazard Index Across Subsurface Soil**					**8.4E-02**
Total Risk Across All Media and All Exposure Routes							**2.E-07**	**Total Hazard Index Across All Media and All Exposure Routes**					**0.08**

NOTES:
NA = Not applicable due to no toxicity values.
-- = No risks calculated for this exposure pathway.

APPENDIX A

SAMPLES USED IN THE HUMAN HEALTH RISK ASSESSMENT

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APPENDIX A - SAMPLES EVALUATED IN THE HHRA
FALCON REFINERY SUPERFUND SITE
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Media	Sample Location	Parent Sample	Final Sample Location	Sample Date
AOC-4				
SB	MW-17-0.5-2.0		MW-17-0.5-2.0	9/10/2013
SB	MW-17-2.0-3.5		MW-17-2.0-3.5	9/10/2013
SB	SO4-01-0.5-2.0		SO4-01-0.5-2.0	9/10/2013
SB	SO4-01-2.0-3.0		SO4-01-2.0-3.0	9/10/2013
SB	SO4-02-0.5-2.0		SO4-02-0.5-2.0	9/10/2013
SB	SO4-02-2.0-3.0		SO4-02-2.0-3.0	9/10/2013
SB	SO4-03-0.5-2.0		SO4-03-0.5-2.0	9/10/2013
SB	SO4-04-0.5-2.0		SO4-04-0.5-2.0	9/10/2013
SB	SO4-04-2.0-3.0		SO4-04-2.0-3.0	9/10/2013
SB	SO4-05-0.5-2.0		SO4-05-0.5-2.0	9/10/2013
SB	SO4-05-2.0-3.0		SO4-05-2.0-3.0	9/10/2013
SS	FR-133A[1]		FR-133A[1]	12/10/2007
SS	MW-17-0.0-0.5		MW-17-0.0-0.5	9/10/2013
SS	SO4-01-0.0-0.5		SO4-01-0.0-0.5	9/10/2013
SS	SO4-01-0.0-0.5 Dup	SO4-01-0.0-0.5	SO4-01-0.0-0.5	9/10/2013
SS	SO4-02-0.0-0.5		SO4-02-0.0-0.5	9/10/2013
SS	SO4-03-0.0-0.5		SO4-03-0.0-0.5	9/10/2013
SS	SO4-04-0.0-0.5		SO4-04-0.0-0.5	9/10/2013
SS	SO4-04-0.0-0.5 Dup	SO4-04-0.0-0.5	SO4-04-0.0-0.5	9/10/2013
SS	SO4-05-0.0-0.5		SO4-05-0.0-0.5	9/10/2013
WG	MW-17		MW-17	9/17/2013

NOTES:
[1] FR-133A is a composite sample.
SB = Subsurface Soil
SS = Surface Soil
WG = Groundwater
SD = Sediment
WS = Surface water

APPENDIX B

ProUCL OUTPUTS

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General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SB_Arsenic

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	11
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.41	Minimum of Log Data	-0.892
Maximum	2.1	Maximum of Log Data	0.742
Mean	1.015	Mean of log Data	-0.0827
Geometric Mean	0.921	SD of log Data	0.456
Median	0.9		
SD	0.498		
Std. Error of Mean	0.144		
Coefficient of Variation	0.49		
Skewness	1.405		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.798	Shapiro Wilk Test Statistic	0.896
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1.273	95% H-UCL	1.361
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.604
95% Adjusted-CLT UCL (Chen-1995)	1.314	97.5% Chebyshev (MVUE) UCL	1.86
95% Modified-t UCL (Johnson-1978)	1.283	99% Chebyshev (MVUE) UCL	2.364
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.017	**Data appear Lognormal at 5% Significance Level**	
Theta Star	0.253		
MLE of Mean	1.015		
MLE of Standard Deviation	0.506		
nu star	96.41		
Approximate Chi Square Value (.05)	74.76	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	1.251
Adjusted Chi Square Value	71.86	95% Jackknife UCL	1.273
		95% Standard Bootstrap UCL	1.238
Anderson-Darling Test Statistic	0.816	95% Bootstrap-t UCL	1.54
Anderson-Darling 5% Critical Value	0.732	95% Hall's Bootstrap UCL	3.193
Kolmogorov-Smirnov Test Statistic	0.289	95% Percentile Bootstrap UCL	1.253
Kolmogorov-Smirnov 5% Critical Value	0.246	95% BCA Bootstrap UCL	1.303
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.641
		97.5% Chebyshev(Mean, Sd) UCL	1.912
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2.445
95% Approximate Gamma UCL (Use when n >= 40)	1.309		
95% Adjusted Gamma UCL (Use when n < 40)	1.362		
Potential UCL to Use		Use 95% Student's-t UCL	1.273
		or 95% Modified-t UCL	1.283
		or 95% H-UCL	1.361

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SB_Benzo(a)anthracene

General Statistics

Number of Valid Data	11	Number of Detected Data	9
Number of Distinct Detected Data	8	Number of Non-Detect Data	2
		Percent Non-Detects	18.18%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0045	Minimum Detected	-5.404
Maximum Detected	0.23	Maximum Detected	-1.47
Mean of Detected	0.0618	Mean of Detected	-3.665
SD of Detected	0.084	SD of Detected	1.427
Minimum Non-Detect	0.0038	Minimum Non-Detect	-5.573
Maximum Non-Detect	0.004	Maximum Non-Detect	-5.521

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	2
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	9
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	18.18%

Warning: There are only 9 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.713	Shapiro Wilk Test Statistic	0.9
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0509	Mean	-4.134
SD	0.0789	SD	1.648
95% DL/2 (t) UCL	0.094	95% H-Stat (DL/2) UCL	0.603
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0409	Mean in Log Scale	-4.283
SD	0.0865	SD in Log Scale	1.876
95% MLE (t) UCL	0.0881	Mean in Original Scale	0.0507
95% MLE (Tiku) UCL	0.0871	SD in Original Scale	0.0791
		95% t UCL	0.0939
		95% Percentile Bootstrap UCL	0.0909
		95% BCA Bootstrap UCL	0.104
		95% H UCL	1.443

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.533	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.116		
nu star	9.585		
A-D Test Statistic	0.656	**Nonparametric Statistics**	
5% A-D Critical Value	0.756	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.756	Mean	0.0514
5% K-S Critical Value	0.29	SD	0.075
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.024
		95% KM (t) UCL	0.0948
Assuming Gamma Distribution		95% KM (z) UCL	0.0908
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0939
Minimum	0.000001	95% KM (bootstrap t) UCL	0.212
Maximum	0.23	95% KM (BCA) UCL	0.0942
Mean	0.0505	95% KM (Percentile Bootstrap) UCL	0.0927
Median	0.0098	95% KM (Chebyshev) UCL	0.156
SD	0.0792	97.5% KM (Chebyshev) UCL	0.201
k star	0.262	99% KM (Chebyshev) UCL	0.29
Theta star	0.193		
Nu star	5.759	**Potential UCLs to Use**	
AppChi2	1.518	95% KM (Chebyshev) UCL	0.156
95% Gamma Approximate UCL (Use when n >= 40)	0.192		
95% Adjusted Gamma UCL (Use when n < 40)	0.244		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SB_Benzo(a)pyrene

General Statistics

Number of Valid Data	11	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	2
		Percent Non-Detects	18.18%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0033	Minimum Detected	-5.714
Maximum Detected	0.25	Maximum Detected	-1.386
Mean of Detected	0.0604	Mean of Detected	-3.664
SD of Detected	0.083	SD of Detected	1.434
Minimum Non-Detect	0.0038	Minimum Non-Detect	-5.573
Maximum Non-Detect	0.004	Maximum Non-Detect	-5.521

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	3
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	8
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	27.27%

Warning: There are only 9 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.728	Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0497	Mean	-4.132
SD	0.0779	SD	1.653
95% DL/2 (t) UCL	0.0923	95% H-Stat (DL/2) UCL	0.617
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0325	Mean in Log Scale	-4.118
SD	0.0931	SD in Log Scale	1.634
95% MLE (t) UCL	0.0834	Mean in Original Scale	0.0498
95% MLE (Tiku) UCL	0.0848	SD in Original Scale	0.0779
		95% t UCL	0.0924
		95% Percentile Bootstrap UCL	0.0893
		95% BCA Bootstrap UCL	0.105
		95% H UCL	0.577

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.544	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.111		
nu star	9.794		
A-D Test Statistic	0.403	**Nonparametric Statistics**	
5% A-D Critical Value	0.755	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.755	Mean	0.05
5% K-S Critical Value	0.29	SD	0.0742
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0237
		95% KM (t) UCL	0.093
Assuming Gamma Distribution		95% KM (z) UCL	0.089
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0921
Minimum	0.000001	95% KM (bootstrap t) UCL	0.193
Maximum	0.25	95% KM (BCA) UCL	0.0942
Mean	0.0494	95% KM (Percentile Bootstrap) UCL	0.091
Median	0.012	95% KM (Chebyshev) UCL	0.153
SD	0.0782	97.5% KM (Chebyshev) UCL	0.198
k star	0.263	99% KM (Chebyshev) UCL	0.286
Theta star	0.187		
Nu star	5.797	**Potential UCLs to Use**	
AppChi2	1.537	95% KM (Chebyshev) UCL	0.153
95% Gamma Approximate UCL (Use when n >= 40)	0.186		
95% Adjusted Gamma UCL (Use when n < 40)	0.237		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SB_Benzo(b)fluoranthene

General Statistics

Number of Valid Data	11	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	2
		Percent Non-Detects	18.18%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0048	Minimum Detected	-5.339
Maximum Detected	0.28	Maximum Detected	-1.273
Mean of Detected	0.0943	Mean of Detected	-3.11
SD of Detected	0.109	SD of Detected	1.417
Minimum Non-Detect	0.0038	Minimum Non-Detect	-5.573
Maximum Non-Detect	0.004	Maximum Non-Detect	-5.521

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	2
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	9
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	18.18%

Warning: There are only 9 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.775	Shapiro Wilk Test Statistic	0.952
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0775	Mean	-3.679
SD	0.104	SD	1.791
95% DL/2 (t) UCL	0.134	95% H-Stat (DL/2) UCL	1.78
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0647	Mean in Log Scale	-3.728
SD	0.115	SD in Log Scale	1.87
95% MLE (t) UCL	0.127	Mean in Original Scale	0.0774
95% MLE (Tiku) UCL	0.127	SD in Original Scale	0.104
		95% t UCL	0.134
		95% Percentile Bootstrap UCL	0.13
		95% BCA Bootstrap UCL	0.144
		95% H UCL	2.44
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.603	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.156		
nu star	10.85		
A-D Test Statistic	0.337	**Nonparametric Statistics**	
5% A-D Critical Value	0.75	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.75	Mean	0.078
5% K-S Critical Value	0.289	SD	0.0988
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0316
		95% KM (t) UCL	0.135
Assuming Gamma Distribution		95% KM (z) UCL	0.13
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.134
Minimum	0.000001	95% KM (bootstrap t) UCL	0.207
Maximum	0.28	95% KM (BCA) UCL	0.134
Mean	0.0772	95% KM (Percentile Bootstrap) UCL	0.131
Median	0.029	95% KM (Chebyshev) UCL	0.216
SD	0.104	97.5% KM (Chebyshev) UCL	0.275
k star	0.264	99% KM (Chebyshev) UCL	0.392
Theta star	0.292		
Nu star	5.807	**Potential UCLs to Use**	
AppChi2	1.542	95% KM (Chebyshev) UCL	0.216
95% Gamma Approximate UCL (Use when n >= 40)	0.291		
95% Adjusted Gamma UCL (Use when n < 40)	0.369		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SB_Dibenz(a,h)anthracene

General Statistics

Number of Valid Data	11	Number of Detected Data	6
Number of Distinct Detected Data	5	Number of Non-Detect Data	5
		Percent Non-Detects	45.45%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.002	Minimum Detected	-6.215
Maximum Detected	0.028	Maximum Detected	-3.576
Mean of Detected	0.00963	Mean of Detected	-5.023
SD of Detected	0.00962	SD of Detected	0.953
Minimum Non-Detect	0.0038	Minimum Non-Detect	-5.573
Maximum Non-Detect	0.11	Maximum Non-Detect	-2.207

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	11
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.79	Shapiro Wilk Test Statistic	0.963
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.011	Mean	-5.27
SD	0.0165	SD	1.193
95% DL/2 (t) UCL	0.02	95% H-Stat (DL/2) UCL	0.0376
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-5.445
		SD in Log Scale	0.859
		Mean in Original Scale	0.0065
		SD in Original Scale	0.00772
		95% t UCL	0.0107
		95% Percentile Bootstrap UCL	0.0104
		95% BCA Bootstrap UCL	0.0125
		95% H-UCL	0.0131
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.841	**Data appear Normal at 5% Significance Level**	
Theta Star	0.0115		
nu star	10.09		
A-D Test Statistic	0.315	**Nonparametric Statistics**	
5% A-D Critical Value	0.708	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.708	Mean	0.0068
5% K-S Critical Value	0.338	SD	0.00765
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.00266
		95% KM (t) UCL	0.0116
Assuming Gamma Distribution		95% KM (z) UCL	0.0112
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0115
Minimum	0.000001	95% KM (bootstrap t) UCL	0.0175
Maximum	0.028	95% KM (BCA) UCL	0.0125
Mean	0.00619	95% KM (Percentile Bootstrap) UCL	0.0118
Median	0.00314	95% KM (Chebyshev) UCL	0.0184
SD	0.00801	97.5% KM (Chebyshev) UCL	0.0234
k star	0.437	99% KM (Chebyshev) UCL	0.0332
Theta star	0.0142		
Nu star	9.619	**Potential UCLs to Use**	
AppChi2	3.705	95% KM (t) UCL	0.0116
95% Gamma Approximate UCL (Use when n >= 40)	0.0161	95% KM (Percentile Bootstrap) UCL	0.0118
95% Adjusted Gamma UCL (Use when n < 40)	0.019		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SB_Indeno(1,2,3-cd)pyrene

General Statistics

Number of Valid Data	11	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	2
		Percent Non-Detects	18.18%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0025	Minimum Detected	-5.991
Maximum Detected	0.2	Maximum Detected	-1.609
Mean of Detected	0.0499	Mean of Detected	-3.759
SD of Detected	0.0641	SD of Detected	1.401
Minimum Non-Detect	0.0038	Minimum Non-Detect	-5.573
Maximum Non-Detect	0.004	Maximum Non-Detect	-5.521

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	3
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	8
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	27.27%

Warning: There are only 9 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.754	Shapiro Wilk Test Statistic	0.986
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0412	Mean	-4.21
SD	0.0605	SD	1.605
95% DL/2 (t) UCL	0.0743	95% H-Stat (DL/2) UCL	0.469
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0281	Mean in Log Scale	-4.209
SD	0.0723	SD in Log Scale	1.603
95% MLE (t) UCL	0.0677	Mean in Original Scale	0.0412
95% MLE (Tiku) UCL	0.0688	SD in Original Scale	0.0605
		95% t UCL	0.0743
		95% Percentile Bootstrap UCL	0.0718
		95% BCA Bootstrap UCL	0.0851
		95% H UCL	0.465
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.595	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.0839		
nu star	10.71		
A-D Test Statistic	0.227	**Nonparametric Statistics**	
5% A-D Critical Value	0.75	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.75	Mean	0.0413
5% K-S Critical Value	0.289	SD	0.0576
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0184
		95% KM (t) UCL	0.0747
Assuming Gamma Distribution		95% KM (z) UCL	0.0716
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.074
Minimum	0.000001	95% KM (bootstrap t) UCL	0.132
Maximum	0.2	95% KM (BCA) UCL	0.0755
Mean	0.0408	95% KM (Percentile Bootstrap) UCL	0.0729
Median	0.016	95% KM (Chebyshev) UCL	0.122
SD	0.0608	97.5% KM (Chebyshev) UCL	0.156
k star	0.272	99% KM (Chebyshev) UCL	0.225
Theta star	0.15		
Nu star	5.976	**Potential UCLs to Use**	
AppChi2	1.627	95% KM (Chebyshev) UCL	0.122
95% Gamma Approximate UCL (Use when n >= 40)	0.15		
95% Adjusted Gamma UCL (Use when n < 40)	0.19		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SB_Mercury

General Statistics

Number of Valid Data	12	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	1
		Percent Non-Detects	8.33%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.006	Minimum Detected	-5.116
Maximum Detected	2.3	Maximum Detected	0.833
Mean of Detected	0.258	Mean of Detected	-3.02
SD of Detected	0.679	SD of Detected	1.657
Minimum Non-Detect	0.11	Minimum Non-Detect	-2.207
Maximum Non-Detect	0.11	Maximum Non-Detect	-2.207

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.404	Shapiro Wilk Test Statistic	0.915
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.241	Mean	-3.01
SD	0.65	SD	1.58
95% DL/2 (t) UCL	0.578	95% H-Stat (DL/2) UCL	1.189
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.073
		SD in Log Scale	1.59
		Mean in Original Scale	0.238
		SD in Original Scale	0.651
		95% t UCL	0.576
		95% Percentile Bootstrap UCL	0.61
		95% BCA Bootstrap UCL	0.804
		95% H-UCL	1.161
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.349	**Data appear Lognormal at 5% Significance Level**	
Theta Star	0.738		
nu star	7.673		
A-D Test Statistic	1.336	**Nonparametric Statistics**	
5% A-D Critical Value	0.801	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.801	Mean	0.239
5% K-S Critical Value	0.273	SD	0.623
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.189
		95% KM (t) UCL	0.578
Assuming Gamma Distribution		95% KM (z) UCL	0.549
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.576
Minimum	0.000001	95% KM (bootstrap t) UCL	4.082
Maximum	2.3	95% KM (BCA) UCL	0.614
Mean	0.236	95% KM (Percentile Bootstrap) UCL	0.609
Median	0.042	95% KM (Chebyshev) UCL	1.061
SD	0.652	97.5% KM (Chebyshev) UCL	1.417
k star	0.267	99% KM (Chebyshev) UCL	2.116
Theta star	0.885		
Nu star	6.399	**Potential UCLs to Use**	
AppChi2	1.847	99% KM (Chebyshev) UCL	2.116
95% Gamma Approximate UCL (Use when n >= 40)	0.818		
95% Adjusted Gamma UCL (Use when n < 40)	1.008		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Aluminum

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7
Raw Statistics		**Log-transformed Statistics**	
Minimum	2000	Minimum of Log Data	7.601
Maximum	17000	Maximum of Log Data	9.741
Mean	4873	Mean of log Data	8.185
Geometric Mean	3588	SD of log Data	0.728
Median	3090		
SD	5392		
Std. Error of Mean	2038		
Coefficient of Variation	1.107		
Skewness	2.555		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.575	Shapiro Wilk Test Statistic	0.763
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	8833	95% H-UCL	11314
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9880
95% Adjusted-CLT UCL (Chen-1995)	10328	97.5% Chebyshev (MVUE) UCL	12218
95% Modified-t UCL (Johnson-1978)	9161	99% Chebyshev (MVUE) UCL	16812
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.113	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	4377		
MLE of Mean	4873		
MLE of Standard Deviation	4618		
nu star	15.59		
Approximate Chi Square Value (.05)	7.67	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	8225
Adjusted Chi Square Value	6.073	95% Jackknife UCL	8833
		95% Standard Bootstrap UCL	7978
Anderson-Darling Test Statistic	1.068	95% Bootstrap-t UCL	26357
Anderson-Darling 5% Critical Value	0.718	95% Hall's Bootstrap UCL	25214
Kolmogorov-Smirnov Test Statistic	0.366	95% Percentile Bootstrap UCL	8800
Kolmogorov-Smirnov 5% Critical Value	0.316	95% BCA Bootstrap UCL	9463
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	13757
		97.5% Chebyshev(Mean, Sd) UCL	17601
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	25152
95% Approximate Gamma UCL (Use when n >= 40)	9901		
95% Adjusted Gamma UCL (Use when n < 40)	12506		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	13757

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Arsenic

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	6

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.94	Minimum of Log Data	-0.0619
Maximum	5.7	Maximum of Log Data	1.74
Mean	2.306	Mean of log Data	0.673
Geometric Mean	1.96	SD of log Data	0.587
Median	2		
SD	1.605		
Std. Error of Mean	0.606		
Coefficient of Variation	0.696		
Skewness	1.969		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.783	Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.484	95% H-UCL	4.385
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4.468
95% Adjusted-CLT UCL (Chen-1995)	3.786	97.5% Chebyshev (MVUE) UCL	5.421
95% Modified-t UCL (Johnson-1978)	3.559	99% Chebyshev (MVUE) UCL	7.293
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.944	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1.186		
MLE of Mean	2.306		
MLE of Standard Deviation	1.654		
nu star	27.21		
Approximate Chi Square Value (.05)	16.31	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	3.303
Adjusted Chi Square Value	13.83	95% Jackknife UCL	3.484
		95% Standard Bootstrap UCL	3.234
Anderson-Darling Test Statistic	0.384	95% Bootstrap-t UCL	4.943
Anderson-Darling 5% Critical Value	0.712	95% Hall's Bootstrap UCL	8.173
Kolmogorov-Smirnov Test Statistic	0.239	95% Percentile Bootstrap UCL	3.357
Kolmogorov-Smirnov 5% Critical Value	0.314	95% BCA Bootstrap UCL	3.634
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.949
		97.5% Chebyshev(Mean, Sd) UCL	6.093
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	8.34
95% Approximate Gamma UCL (Use when n >= 40)	3.846		
95% Adjusted Gamma UCL (Use when n < 40)	4.536		
Potential UCL to Use		Use 95% Approximate Gamma UCL	3.846

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Benzo(a)anthracene

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	6
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.063	Minimum of Log Data	-2.765
Maximum	0.59	Maximum of Log Data	-0.528
Mean	0.225	Mean of log Data	-1.858
Geometric Mean	0.156	SD of log Data	0.888
Median	0.1		
SD	0.219		
Std. Error of Mean	0.0827		
Coefficient of Variation	0.971		
Skewness	1.239		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

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If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.737	Shapiro Wilk Test Statistic	0.845
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.386	95% H-UCL	0.789
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.533
95% Adjusted-CLT UCL (Chen-1995)	0.403	97.5% Chebyshev (MVUE) UCL	0.671
95% Modified-t UCL (Johnson-1978)	0.392	99% Chebyshev (MVUE) UCL	0.941
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.956	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	0.235		
MLE of Mean	0.225		
MLE of Standard Deviation	0.23		
nu star	13.39		
Approximate Chi Square Value (.05)	6.155	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	0.361
Adjusted Chi Square Value	4.757	95% Jackknife UCL	0.386
		95% Standard Bootstrap UCL	0.351
Anderson-Darling Test Statistic	0.755	95% Bootstrap-t UCL	1.158
Anderson-Darling 5% Critical Value	0.721	95% Hall's Bootstrap UCL	1.332
Kolmogorov-Smirnov Test Statistic	0.294	95% Percentile Bootstrap UCL	0.36
Kolmogorov-Smirnov 5% Critical Value	0.317	95% BCA Bootstrap UCL	0.388
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.585
		97.5% Chebyshev(Mean, Sd) UCL	0.741
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.048
95% Approximate Gamma UCL (Use when n >= 40)	0.49		
95% Adjusted Gamma UCL (Use when n < 40)	0.634		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.49

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Benzo(a)pyrene

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		Log-transformed Statistics	
Minimum	0.053	Minimum of Log Data	-2.937
Maximum	0.5	Maximum of Log Data	-0.693
Mean	0.216	Mean of log Data	-1.838
Geometric Mean	0.159	SD of log Data	0.843
Median	0.16		
SD	0.182		
Std. Error of Mean	0.0689		
Coefficient of Variation	0.844		
Skewness	1.048		

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If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.802	Shapiro Wilk Test Statistic	0.926
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.35	95% H-UCL	0.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.512
95% Adjusted-CLT UCL (Chen-1995)	0.358	97.5% Chebyshev (MVUE) UCL	0.641
95% Modified-t UCL (Johnson-1978)	0.354	99% Chebyshev (MVUE) UCL	0.895
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.118	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.193		
MLE of Mean	0.216		
MLE of Standard Deviation	0.204		
nu star	15.65		
Approximate Chi Square Value (.05)	7.715	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	0.329
Adjusted Chi Square Value	6.111	95% Jackknife UCL	0.35
		95% Standard Bootstrap UCL	0.321
Anderson-Darling Test Statistic	0.446	95% Bootstrap-t UCL	0.626
Anderson-Darling 5% Critical Value	0.718	95% Hall's Bootstrap UCL	1.234
Kolmogorov-Smirnov Test Statistic	0.243	95% Percentile Bootstrap UCL	0.326
Kolmogorov-Smirnov 5% Critical Value	0.316	95% BCA Bootstrap UCL	0.338
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.516
		97.5% Chebyshev(Mean, Sd) UCL	0.646
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.901
95% Approximate Gamma UCL (Use when n >= 40)	0.438		
95% Adjusted Gamma UCL (Use when n < 40)	0.553		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.438

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Benzo(b)fluoranthene

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		Log-transformed Statistics	
Minimum	0.1	Minimum of Log Data	-2.303
Maximum	0.82	Maximum of Log Data	-0.198
Mean	0.366	Mean of log Data	-1.291
Geometric Mean	0.275	SD of log Data	0.801
Median	0.222		
SD	0.308		
Std. Error of Mean	0.116		
Coefficient of Variation	0.841		
Skewness	1.109		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

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If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

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Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.75	Shapiro Wilk Test Statistic	0.889
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.592	95% H-UCL	1.064
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.836
95% Adjusted-CLT UCL (Chen-1995)	0.609	97.5% Chebyshev (MVUE) UCL	1.042
95% Modified-t UCL (Johnson-1978)	0.6	99% Chebyshev (MVUE) UCL	1.447
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.182	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.31		
MLE of Mean	0.366		
MLE of Standard Deviation	0.337		
nu star	16.54		
Approximate Chi Square Value (.05)	8.347	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	0.557
Adjusted Chi Square Value	6.667	95% Jackknife UCL	0.592
		95% Standard Bootstrap UCL	0.543
Anderson-Darling Test Statistic	0.625	95% Bootstrap-t UCL	1.339
Anderson-Darling 5% Critical Value	0.716	95% Hall's Bootstrap UCL	2.507
Kolmogorov-Smirnov Test Statistic	0.292	95% Percentile Bootstrap UCL	0.55
Kolmogorov-Smirnov 5% Critical Value	0.315	95% BCA Bootstrap UCL	0.563
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.873
		97.5% Chebyshev(Mean, Sd) UCL	1.092
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.523
95% Approximate Gamma UCL (Use when n >= 40)	0.725		
95% Adjusted Gamma UCL (Use when n < 40)	0.908		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.725

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Cobalt

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.72	Minimum of Log Data	-0.329
Maximum	3.8	Maximum of Log Data	1.335
Mean	1.485	Mean of log Data	0.228
Geometric Mean	1.256	SD of log Data	0.58
Median	0.935		
SD	1.084		
Std. Error of Mean	0.41		
Coefficient of Variation	0.73		
Skewness	2.076		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

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If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.726	Shapiro Wilk Test Statistic	0.864
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2.281	95% H-UCL	2.768
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.837
95% Adjusted-CLT UCL (Chen-1995)	2.503	97.5% Chebyshev (MVUE) UCL	3.439
95% Modified-t UCL (Johnson-1978)	2.335	99% Chebyshev (MVUE) UCL	4.621
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.892	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.785		
MLE of Mean	1.485		
MLE of Standard Deviation	1.08		
nu star	26.49		
Approximate Chi Square Value (.05)	15.76	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	2.159
Adjusted Chi Square Value	13.32	95% Jackknife UCL	2.281
		95% Standard Bootstrap UCL	2.11
Anderson-Darling Test Statistic	0.63	95% Bootstrap-t UCL	3.724
Anderson-Darling 5% Critical Value	0.712	95% Hall's Bootstrap UCL	4.468
Kolmogorov-Smirnov Test Statistic	0.286	95% Percentile Bootstrap UCL	2.201
Kolmogorov-Smirnov 5% Critical Value	0.314	95% BCA Bootstrap UCL	2.427
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3.271
		97.5% Chebyshev(Mean, Sd) UCL	4.044
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	5.562
95% Approximate Gamma UCL (Use when n >= 40)	2.497		
95% Adjusted Gamma UCL (Use when n < 40)	2.953		
Potential UCL to Use		Use 95% Approximate Gamma UCL	2.497

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Copper

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7
Raw Statistics		**Log-transformed Statistics**	
Minimum	2.8	Minimum of Log Data	1.03
Maximum	39.8	Maximum of Log Data	3.684
Mean	14.53	Mean of log Data	2.145
Geometric Mean	8.539	SD of log Data	1.062
Median	5.3		
SD	16.65		
Std. Error of Mean	6.293		
Coefficient of Variation	1.146		
Skewness	1.22		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

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Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.66	Shapiro Wilk Test Statistic	0.773
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	26.76	95% H-UCL	80.39
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	37.13
95% Adjusted-CLT UCL (Chen-1995)	27.98	97.5% Chebyshev (MVUE) UCL	47.36
95% Modified-t UCL (Johnson-1978)	27.24	99% Chebyshev (MVUE) UCL	67.45
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.711	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	20.44		
MLE of Mean	14.53		
MLE of Standard Deviation	17.23		
nu star	9.949		
Approximate Chi Square Value (.05)	3.91	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	24.88
Adjusted Chi Square Value	2.854	95% Jackknife UCL	26.76
		95% Standard Bootstrap UCL	24.16
Anderson-Darling Test Statistic	1.088	95% Bootstrap-t UCL	163.6
Anderson-Darling 5% Critical Value	0.727	95% Hall's Bootstrap UCL	299.6
Kolmogorov-Smirnov Test Statistic	0.4	95% Percentile Bootstrap UCL	24.4
Kolmogorov-Smirnov 5% Critical Value	0.319	95% BCA Bootstrap UCL	24.96
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	41.96
		97.5% Chebyshev(Mean, Sd) UCL	53.83
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	77.15
95% Approximate Gamma UCL (Use when n >= 40)	36.97		
95% Adjusted Gamma UCL (Use when n < 40)	50.64		
Potential UCL to Use		Use 95% Hall's Bootstrap UCL	299.6

Recommended UCL exceeds the maximum observation
In Case Bootstrap t and/or Hall's Bootstrap yields an unreasonably large UCL value, use 97.5% or 99% Chebyshev (Mean, Sd) UCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Dibenz(a,h)anthracene

General Statistics

Number of Valid Data	6	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	1
		Percent Non-Detects	16.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.01	Minimum Detected	-4.605
Maximum Detected	0.076	Maximum Detected	-2.577
Mean of Detected	0.0472	Mean of Detected	-3.305
SD of Detected	0.0302	SD of Detected	0.884
Minimum Non-Detect	0.072	Minimum Non-Detect	-2.631
Maximum Non-Detect	0.072	Maximum Non-Detect	-2.631

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.878	Shapiro Wilk Test Statistic	0.864
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0453	Mean	-3.308
SD	0.0274	SD	0.791
95% DL/2 (t) UCL	0.0679	95% H-Stat (DL/2) UCL	0.169
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.39
		SD in Log Scale	0.818
		Mean in Original Scale	0.043
		SD in Original Scale	0.0289
		95% t UCL	0.0668
		95% Percentile Bootstrap UCL	0.0608
		95% BCA Bootstrap UCL	0.0627
		95% H-UCL	0.171
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.988	**Data appear Normal at 5% Significance Level**	
Theta Star	0.0478		
nu star	9.878		
A-D Test Statistic	0.421	**Nonparametric Statistics**	
5% A-D Critical Value	0.684	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.684	Mean	0.0441
5% K-S Critical Value	0.36	SD	0.0267
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0128
		95% KM (t) UCL	0.0698
Assuming Gamma Distribution		95% KM (z) UCL	0.0651
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0705
Minimum	0.01	95% KM (bootstrap t) UCL	0.068
Maximum	0.076	95% KM (BCA) UCL	0.0642
Mean	0.0439	95% KM (Percentile Bootstrap) UCL	0.0643
Median	0.0402	95% KM (Chebyshev) UCL	0.0998
SD	0.0282	97.5% KM (Chebyshev) UCL	0.124
k star	1.283	99% KM (Chebyshev) UCL	0.171
Theta star	0.0342		
Nu star	15.39	**Potential UCLs to Use**	
AppChi2	7.534	95% KM (t) UCL	0.0698
95% Gamma Approximate UCL (Use when n >= 40)	0.0896	95% KM (Percentile Bootstrap) UCL	0.0643
95% Adjusted Gamma UCL (Use when n < 40)	0.119		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Indeno(1,2,3-cd)pyrene

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	6

Raw Statistics		Log-transformed Statistics	
Minimum	0.05	Minimum of Log Data	-2.996
Maximum	0.35	Maximum of Log Data	-1.05
Mean	0.178	Mean of log Data	-1.95
Geometric Mean	0.142	SD of log Data	0.743
Median	0.15		
SD	0.124		
Std. Error of Mean	0.047		
Coefficient of Variation	0.698		
Skewness	0.782		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.844	Shapiro Wilk Test Statistic	0.934
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.269	95% H-UCL	0.467
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.4
95% Adjusted-CLT UCL (Chen-1995)	0.27	97.5% Chebyshev (MVUE) UCL	0.495
95% Modified-t UCL (Johnson-1978)	0.272	99% Chebyshev (MVUE) UCL	0.683
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.455	Data appear Normal at 5% Significance Level	
Theta Star	0.122		
MLE of Mean	0.178		
MLE of Standard Deviation	0.148		
nu star	20.37		
Approximate Chi Square Value (.05)	11.12	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	0.255
Adjusted Chi Square Value	9.131	95% Jackknife UCL	0.269
		95% Standard Bootstrap UCL	0.249
Anderson-Darling Test Statistic	0.333	95% Bootstrap-t UCL	0.357
Anderson-Darling 5% Critical Value	0.714	95% Hall's Bootstrap UCL	0.881
Kolmogorov-Smirnov Test Statistic	0.202	95% Percentile Bootstrap UCL	0.253
Kolmogorov-Smirnov 5% Critical Value	0.315	95% BCA Bootstrap UCL	0.255
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.383
		97.5% Chebyshev(Mean, Sd) UCL	0.472
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.646
95% Approximate Gamma UCL (Use when n >= 40)	0.326		
95% Adjusted Gamma UCL (Use when n < 40)	0.397		
Potential UCL to Use		Use 95% Student's-t UCL	0.269

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Iron

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		Log-transformed Statistics	
Minimum	2250	Minimum of Log Data	7.719
Maximum	13000	Maximum of Log Data	9.473
Mean	5262	Mean of log Data	8.387
Geometric Mean	4388	SD of log Data	0.622
Median	3770		
SD	3800		
Std. Error of Mean	1436		
Coefficient of Variation	0.722		
Skewness	1.736		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.805	Shapiro Wilk Test Statistic	0.933
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	8053	95% H-UCL	10617
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10479
95% Adjusted-CLT UCL (Chen-1995)	8631	97.5% Chebyshev (MVUE) UCL	12780
95% Modified-t UCL (Johnson-1978)	8210	99% Chebyshev (MVUE) UCL	17300
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.757	**Data appear Normal at 5% Significance Level**	
Theta Star	2996		
MLE of Mean	5262		
MLE of Standard Deviation	3970		
nu star	24.59		
Approximate Chi Square Value (.05)	14.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	7624
Adjusted Chi Square Value	12	95% Jackknife UCL	8053
		95% Standard Bootstrap UCL	7415
Anderson-Darling Test Statistic	0.381	95% Bootstrap-t UCL	12038
Anderson-Darling 5% Critical Value	0.712	95% Hall's Bootstrap UCL	17948
Kolmogorov-Smirnov Test Statistic	0.203	95% Percentile Bootstrap UCL	7646
Kolmogorov-Smirnov 5% Critical Value	0.314	95% BCA Bootstrap UCL	8337
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	11522
		97.5% Chebyshev(Mean, Sd) UCL	14231
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	19552
95% Approximate Gamma UCL (Use when n >= 40)	9049		
95% Adjusted Gamma UCL (Use when n < 40)	10785		
Potential UCL to Use		Use 95% Student's-t UCL	8053

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Lead

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		Log-transformed Statistics	
Minimum	8.6	Minimum of Log Data	2.152
Maximum	483.9	Maximum of Log Data	6.182
Mean	83.61	Mean of log Data	3.168
Geometric Mean	23.76	SD of log Data	1.423
Median	12.9		
SD	176.9		
Std. Error of Mean	66.86		
Coefficient of Variation	2.116		
Skewness	2.622		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.498	Shapiro Wilk Test Statistic	0.701
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	213.5	95% H-UCL	1160
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	173.1
95% Adjusted-CLT UCL (Chen-1995)	264.4	97.5% Chebyshev (MVUE) UCL	225.4
95% Modified-t UCL (Johnson-1978)	224.6	99% Chebyshev (MVUE) UCL	328
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.383	Data do not follow a Discernable Distribution (0.05)	
Theta Star	218.1		
MLE of Mean	83.61		
MLE of Standard Deviation	135		
nu star	5.367		
Approximate Chi Square Value (.05)	1.326	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	193.6
Adjusted Chi Square Value	0.815	95% Jackknife UCL	213.5
		95% Standard Bootstrap UCL	185.7
Anderson-Darling Test Statistic	1.411	95% Bootstrap-t UCL	7795
Anderson-Darling 5% Critical Value	0.751	95% Hall's Bootstrap UCL	4866
Kolmogorov-Smirnov Test Statistic	0.409	95% Percentile Bootstrap UCL	214.1
Kolmogorov-Smirnov 5% Critical Value	0.327	95% BCA Bootstrap UCL	281.6
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	375
		97.5% Chebyshev(Mean, Sd) UCL	501.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	748.8
95% Approximate Gamma UCL (Use when n >= 40)	338.5		
95% Adjusted Gamma UCL (Use when n < 40)	550.6		
Potential UCL to Use		Use 95% Hall's Bootstrap UCL	4866

Recommended UCL exceeds the maximum observation
In Case Bootstrap t and/or Hall's Bootstrap yields an unreasonably large UCL value, use 97.5% or 99% Chebyshev (Mean, Sd) UCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Manganese

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		Log-transformed Statistics	
Minimum	65	Minimum of Log Data	4.174
Maximum	259	Maximum of Log Data	5.557
Mean	123.3	Mean of log Data	4.727
Geometric Mean	112.9	SD of log Data	0.429
Median	106		
SD	63.58		
Std. Error of Mean	24.03		
Coefficient of Variation	0.516		
Skewness	2.033		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.767	Shapiro Wilk Test Statistic	0.905
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	170	95% H-UCL	186.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	208.8
95% Adjusted-CLT UCL (Chen-1995)	182.6	97.5% Chebyshev (MVUE) UCL	246.4
95% Modified-t UCL (Johnson-1978)	173.1	99% Chebyshev (MVUE) UCL	320.1
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.42	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	36.06		
MLE of Mean	123.3		
MLE of Standard Deviation	66.69		
nu star	47.88		
Approximate Chi Square Value (.05)	33	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	162.9
Adjusted Chi Square Value	29.32	95% Jackknife UCL	170
		95% Standard Bootstrap UCL	159.9
Anderson-Darling Test Statistic	0.549	95% Bootstrap-t UCL	243.9
Anderson-Darling 5% Critical Value	0.71	95% Hall's Bootstrap UCL	387.8
Kolmogorov-Smirnov Test Statistic	0.283	95% Percentile Bootstrap UCL	164.8
Kolmogorov-Smirnov 5% Critical Value	0.313	95% BCA Bootstrap UCL	178.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	228.1
		97.5% Chebyshev(Mean, Sd) UCL	273.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	362.5
95% Approximate Gamma UCL (Use when n >= 40)	179		
95% Adjusted Gamma UCL (Use when n < 40)	201.4		
Potential UCL to Use		Use 95% Approximate Gamma UCL	179

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS_Mercury

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		Log-transformed Statistics	
Minimum	0.13	Minimum of Log Data	-2.04
Maximum	1.5	Maximum of Log Data	0.405
Mean	0.531	Mean of log Data	-0.909
Geometric Mean	0.403	SD of log Data	0.789
Median	0.43		
SD	0.463		
Std. Error of Mean	0.175		
Coefficient of Variation	0.872		
Skewness	1.888		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.799	Shapiro Wilk Test Statistic	0.984
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.871	95% H-UCL	1.506
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.205
95% Adjusted-CLT UCL (Chen-1995)	0.953	97.5% Chebyshev (MVUE) UCL	1.501
95% Modified-t UCL (Johnson-1978)	0.892	99% Chebyshev (MVUE) UCL	2.081

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.218	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.436		
MLE of Mean	0.531		
MLE of Standard Deviation	0.481		
nu star	17.05		
Approximate Chi Square Value (.05)	8.706	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	0.819
Adjusted Chi Square Value	6.983	95% Jackknife UCL	0.871
		95% Standard Bootstrap UCL	0.798
Anderson-Darling Test Statistic	0.277	95% Bootstrap-t UCL	1.319
Anderson-Darling 5% Critical Value	0.715	95% Hall's Bootstrap UCL	2.199
Kolmogorov-Smirnov Test Statistic	0.185	95% Percentile Bootstrap UCL	0.824
Kolmogorov-Smirnov 5% Critical Value	0.315	95% BCA Bootstrap UCL	0.93
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.294
		97.5% Chebyshev(Mean, Sd) UCL	1.625
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2.273
95% Approximate Gamma UCL (Use when n >= 40)	1.04		
95% Adjusted Gamma UCL (Use when n < 40)	1.296		

Potential UCL to Use		Use 95% Approximate Gamma UCL	1.04

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

APPENDIX C

CONSTRUCTION WORKER PARTICULATE EMISSION FACTOR

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Site-specific

Construction Worker Equation Inputs for Soil - Other than Standard Vehicle Traffic

Variable	Value
TR (target cancer risk) unitless	1.0E-6
THQ (target hazard quotient) unitless	1
AT_{cw} (averaging time - construction worker)	365
EF_{cw} (exposure frequency - construction worker) day/yr	250
ED_{cw} (exposure duration - construction worker) yr	1
ET_{cw} (exposure time - construction worker) hr	8
LT (lifetime) yr	70
BW_{cw} (body weight - construction worker) kg	70
IR_{cw} (soil ingestion rate - construction worker) mg/day	330
SA_{cw} (surface area - construction worker) cm^2/day	3300
AF_{cw} (skin adherence factor - construction worker) mg/cm^2	0.3
A_{till} (areal extent of tilling) acres	1.7
A_{excav} (area of excavation site) m^2	1.7
$A_{c\text{-}grade}$ (area of grading) acres	1.7
$A_{c\text{-}grade}$ (area of dozing) acres	1.7
A_{surf} (areal extent of site) m^2	2023.43
$M_{m\text{-}doz}$ (Gravimetric soil moisture content) %	7.9
$M_{m\text{-}excav}$ (Gravimetric soil moisture content) %	12
ρ$_{soil}$ (density) g/cm^3 - chemical-specific	1.68
$N_{A\text{-}dump}$ (number of times soil is dumped)	2
$N_{A\text{-}till}$ (number of times soil is tilled)	2
s_{till} (soil silt content) %	18
s_{doz} (soil silt content) %	6.9
B_l (dozing blade length) m	12
B_l (grading blade length) m	12
N (number of times site was dozed)	2
N (number of times site was graded)	1
S (dozing speed) kph	6.9
S (dozing speed) kph	11.4
d_{excav} (average depth of excavation site) m	1.5

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Site-specific

Construction Worker Equation Inputs for Soil - Other than Standard Vehicle Traffic

Variable	Value
T (time over which construction occurs) s	7200000
$J`_T$ (g/m^{2}s)	0.0000041285792
F(x) (function dependant on U_m/U_t derived using Cowherd et al. (1985))	0.194
U_t (equivalent threshold value) m/s	11.32
U_m (mean annual wind speed) m/s	4.69
V (fraction of vegetative cover)	0
M_{wind} (dust emitted by wind erosion) g	51288.84717
M_{doz} (dust emitted from dozing operations) g	34.071833870843
M_{till} (dust emitted from tilling operations) g	8573.7005230242
M_{grade} (dust emitted from grading operations) g	250.35130512000
M_{excav} (dust emitted from excavation soil dumping) g	1.0447946612478
ΣVKT_{doz} (sum of fleet vehicle km traveled) km	1.1466500000000
ΣVKT_{grade} (sum of fleet vehicle km traveled) km	0.5733250000000
Q/C_{sa} (inverse of the ratio of the geometric mean air concentration to the emission flu	14.31407
$PEF`_{sc}$ (particulate emission factor) m^3/kg	18656485.799800
A (PEF Dispersion Constant)	2.4538
B (PEF Dispersion Constant)	17.5660
C (PEF Dispersion Constant)	189.0426
T (temperature) °C	25
foc (fraction organic carbon in soil) g/g	0.006
ρ$_b$ (dry soil bulk density) g/cm^3	1.5
ρ$_s$ (soil particle density) g/cm^3	2.65
A (VF Dispersion Constant)	2.4538
B (VF Dispersion Constant)	17.5660
C (VF Dispersion Constant)	189.0426
T (exposure interval) s	31536000
Q/C_{sa} (inverse of the ratio of the geometric mean air concentration to the emission flu	14.31407
n (total soil porosity) L $_{pore}$/L$_{soil}$	0.43396
θ$_w$ (water-filled soil porosity) L $_{water}$/L$_{soil}$	0.15
θ$_a$ (air-filled soil porosity) L $_{air}$/L$_{soil}$	0.28396

Site-specific

Construction Worker Screening Levels (RSL) for Soil - Other than Standard Vehicle Traffic

ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL), max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat,
Smax=Soil SL exceeds ceiling limit and has been substituted with the max value (see User's Guide),
Ssat=Soil inhalation SL exceeds csat and has been substituted with the csat

Chemical	CAS Number	Mutagen?	VOC?	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	Subchronic RfD (mg/kg-day)	SRfD Ref	Subchronic RfC (mg/m^3)	SRfC Ref	GIABS	ABS	RBA	Volatilization Factor (m^3/kg)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	I	4.30E-03	I	-		-		1	0.03	0.6	-
Benzo[a]pyrene	50-32-8	Yes	No	7.30E+00	I	1.10E-03	C	-		-		1	0.13	1	-
Benzo[b]fluoranthene	205-99-2	Yes	No	7.30E-01	W	1.10E-04	C	-		-		1	0.13	1	-

Chemical	Soil Saturation Concentration (mg/kg)	Apparent Diffusivity (cm²/s)	D_{ia} cm²/s)	D_{iw} cm²/s)	Henrys law constant	K_d (cm³/g)	K_{oc} (cm3/g)
Arsenic, Inorganic	-	-	-	-	-	29	-
Benzo[a]pyrene	-	-	0.0475831	5.5597E-6	0.0000187	-	587400
Benzo[b]fluoranthene	-	-	0.0475831	5.5597E-6	0.0000269	-	599400

Chemical	Particulate Emission Factor (m^3/kg)	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	1.87E+07	2.41E+01	1.61E+02	1.33E+03	2.06E+01	1.55E+02	1.03E+03	1.23E+03	1.21E+02	2.06E+01 ca**
Benzo[a]pyrene	1.87E+07	2.97E+00	7.61E+00	5.20E+03	2.14E+00	-	-	-	-	2.14E+00 ca
Benzo[b]fluoranthene	1.87E+07	2.97E+01	7.61E+01	5.20E+04	2.14E+01	-	-	-	-	2.14E+01 ca

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APPENDIX D

IEUBK BLOOD-LEAD MODEL OUTPUTS

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LEAD MODEL FOR WINDOWS Version 1.1

==
Model Version: 1.1 Build11
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 68.520 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	83.600	68.520
1-2	83.600	68.520
2-3	83.600	68.520
3-4	83.600	68.520
4-5	83.600	68.520
5-6	83.600	68.520
6-7	83.600	68.520

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

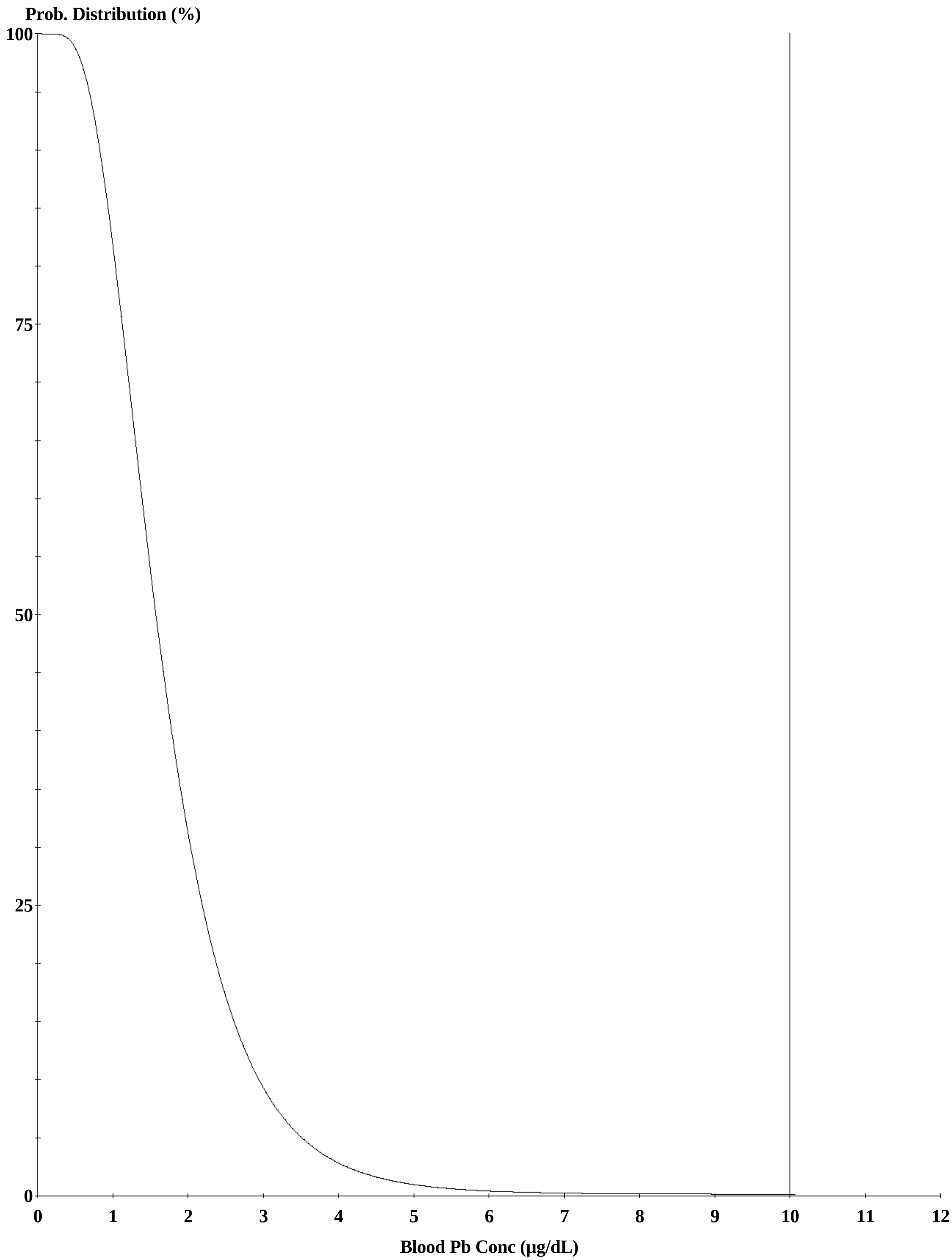
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 1.000 µg Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.021	1.088	0.000	0.385
1-2	0.034	0.940	0.000	0.959
2-3	0.062	1.027	0.000	1.002
3-4	0.067	0.988	0.000	1.027
4-5	0.067	0.953	0.000	1.075
5-6	0.093	1.005	0.000	1.137
6-7	0.093	1.090	0.000	1.159

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	1.849	3.344	1.8
1-2	2.924	4.857	2.0
2-3	2.940	5.031	1.9
3-4	2.956	5.038	1.8
4-5	2.208	4.302	1.5
5-6	1.993	4.228	1.3
6-7	1.885	4.227	1.2



Cutoff = 10.000 µg/dl
Geo Mean = 1.646
GSD = 1.600
% Above = 0.006

Age Range = 0 to 84 months

Run Mode = Research